



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>

ON THE
EXTENSION OF ENGLISH COALFIELDS
beneath
THE SECONDARY FORMATIONS,
ETC.

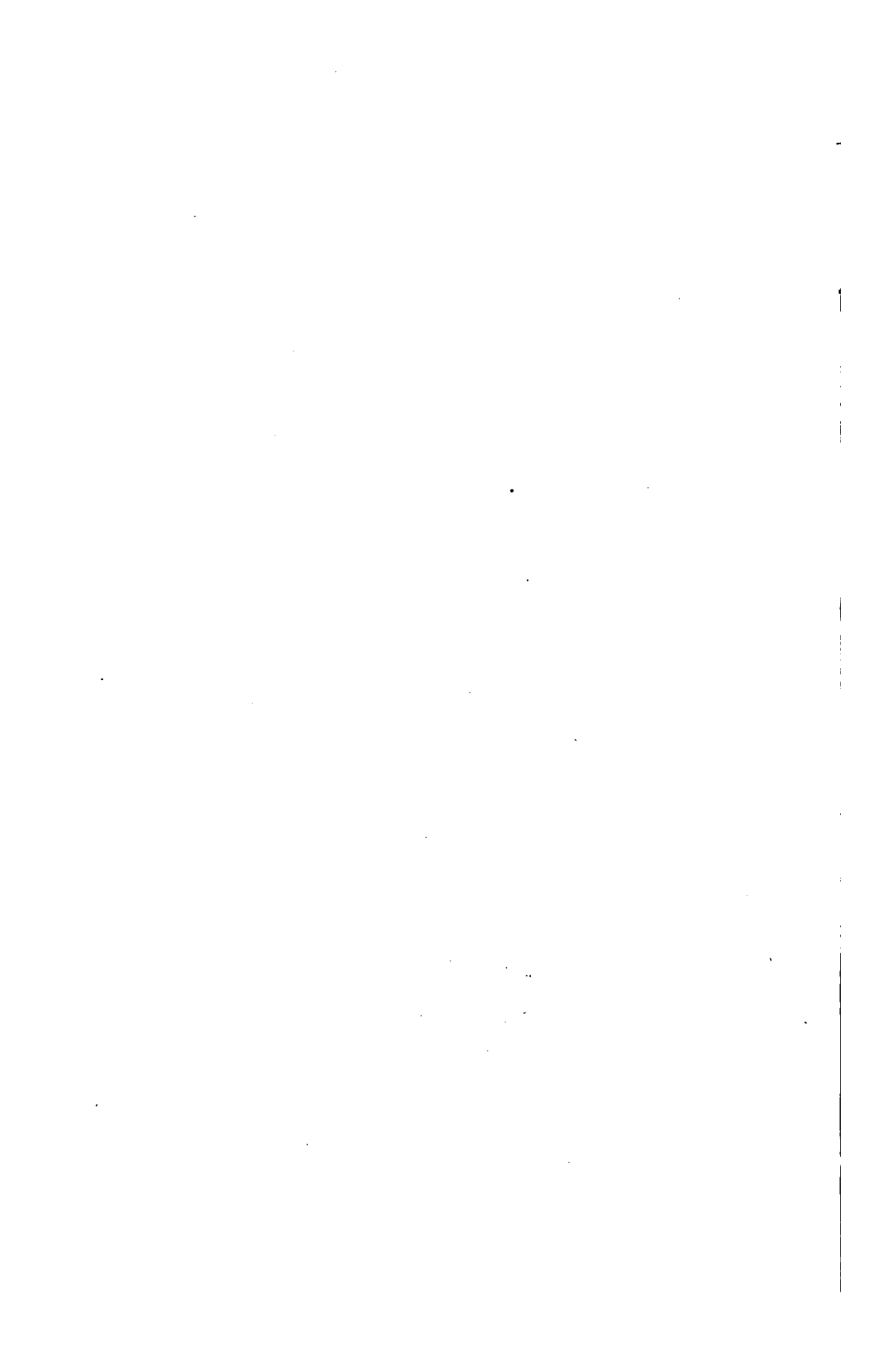






**ON THE
EXTENSION OF THE ENGLISH COALFIELDS**

**BENEATH THE
SECONDARY FORMATIONS OF THE
MIDLAND COUNTIES.**



ON THE EXTENSION
OF THE
ENGLISH COAL-FIELDS
BENEATH THE
SECONDARY FORMATIONS OF THE
MIDLAND COUNTIES.

ALSO,
DOES COAL EXIST NEAR LONDON?
GEOLOGICALLY CONSIDERED.

By JOSEPH HOLDSWORTH, Esq., M.G.S.F.,
&c., &c.;

AUTHOR OF "A BATTLE WITH THE BASALTS," "GEOLOGY AND MINERAL RESOURCES OF WALES,"
"GEOLOGY, MINERALS, AND SOILS OF IRELAND," "RURAL SCENERY," &c., &c.



LONDON:
R. MIDDLETON, 26, FLEET STREET.
1866

188. e. 10.

DEDICATION.

TO THE RIGHT HON. LORD BERNERS.

MY LORD,

It is with more than ordinary feelings of gratification, afforded on occasions like the present, that I avail myself of the permission to dedicate this little work to your Lordship. From vivid recollections of the patronage and encouragement at all times accorded by your Lordship to any measures having an inherent tendency to develop the natural resources and facilitate the progress and prosperity of our common country, I am agreeably conscious that the subject-matter of the following pages will not only be welcomed with a cordial approval, but enlist your Lordship's warmest sympathies for a thoroughly successful revealment of the great, I may truly say national problem, they are designed to set forth, and, it is trusted, to elucidate without partiality or prejudice.

Your Lordship's knowledge of my early predilections for investigations of this nature, and familiar acquaintance with certain manifestations I at that period prominently exhibited, will, I am persuaded, abundantly satisfy your Lordship of my sincerity and earnestness in the particular views and expositions I now, fortified by extensive subsequent experiences, essay to promulgate for the public weal.

I have the honour to remain,

Your Lordship's

Most obedient Servant,

JOSEPH HOLDSWORTH.

C O N T E N T S.

	PAGE
PREFACE	xiii

CHAPTER I.

COAL—THE MAINSPRING OF OUR NATIONAL PROSPERITY : ITS PERMANENT AND ECONOMIC SUPPLY OF PARAMOUNT IMPORTANCE	17
---	----

CHAPTER II.

PROBABLE EARLY EXHAUSTION OF OUR NORTHERN AND MIDLAND COALFIELDS	21
--	----

CHAPTER III.

GEOGRAPHICAL EXTENT AND MATERIAL CAPACITIES OF THE PRINCIPAL ENGLISH COALFIELDS	26
---	----

CHAPTER IV.

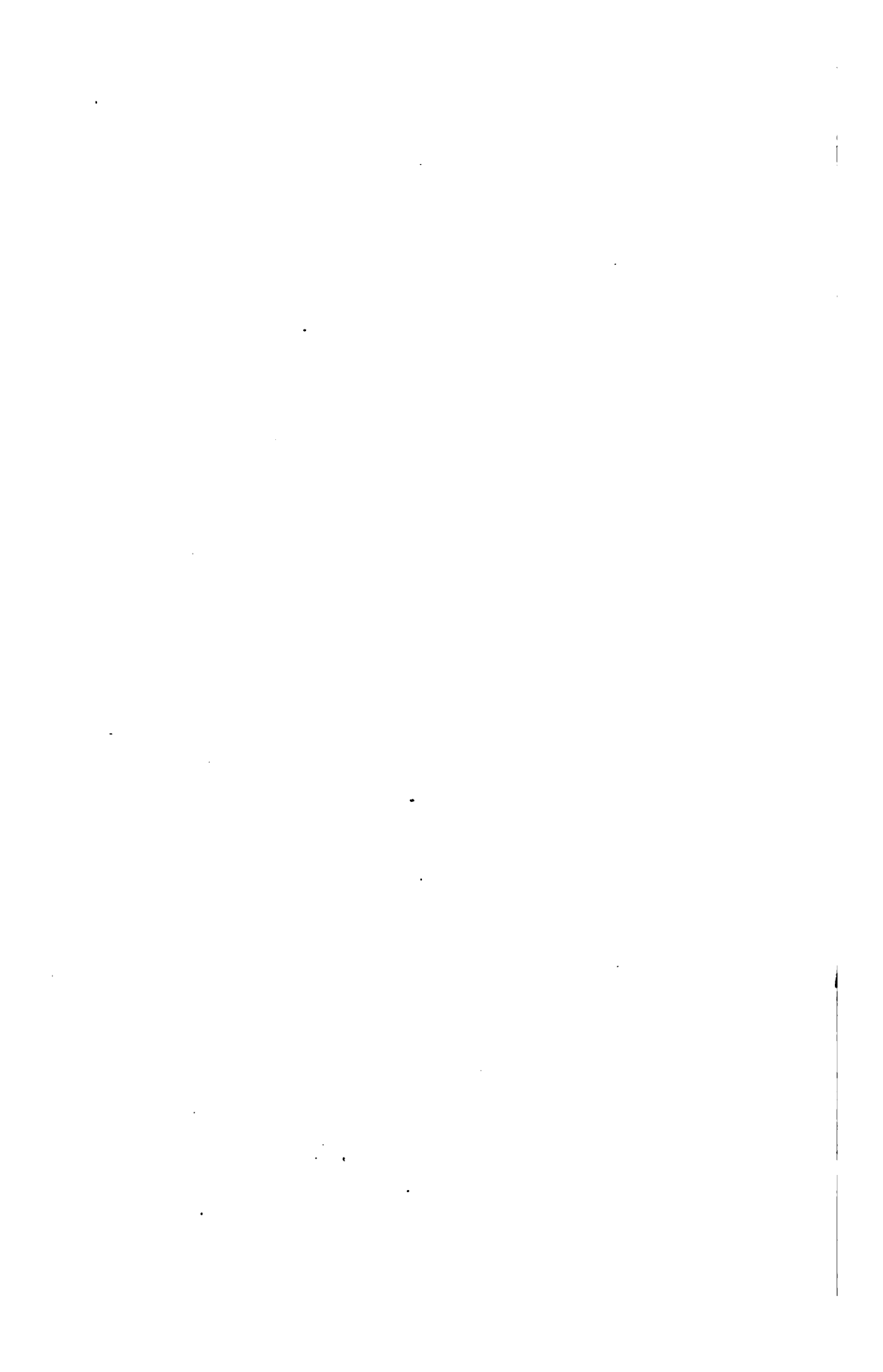
ON THE PROBABLE EXTENSION, BY GEOLOGICAL INDUCTION, OF OUR COALFIELDS BENEATH THE NEWER FORMA- TIONS OF THE MIDLAND AND SOUTHERN COUNTIES OF THE KINGDOM	35
--	----

CHAPTER V.

DOES COAL EXIST NEAR LONDON? GEOLOGICALLY CON- SIDERED	67
--	----

CHAPTER VI.

PROVISION AND PURPOSES OF THE CREATOR	105
--	-----



P R E F A C E.

THE interest and importance attached to the grand problem which furnishes the primary subject-matter of the following Treatise, is, avowedly, so surpassing, that it were hardly necessary to apologise for this introduction of it to public notice.

For nearly thirty years, it has constituted a leading feature in the Author's researches, as a practical geologist; and almost as far back as that period, both with regard to private experiment and public controversy, he gave indubitable proof of the force and sincerity of the convictions he has mainly endeavoured to elucidate in the following pages. From the peculiar physical character of the question, it has not been possible to adduce any very direct evidences of a special, or indicative, local description, in attestation of the existence of the Carboniferous series, beneath the Secondary Formations of the unexplored districts of England, and hence, the geological disquisitions entered into, have necessarily been of a more general and comprehensive character. The results of actual experiments, in the future, and the minuter investigations of able geologists whose

interest may soon become more especially directed to the solution, in the main, of this inviting problem, will all gradually contribute to the introduction of interesting, and positive details, into the outline herein delineated.

Of the observed facts, and various statistical statements, which have been adduced in corroboration of the several positions sought to be maintained, it may simply be predicated that, they are striking corollaries of the *National* character of the question under consideration.

Our noble Coalfields, have long been the theme of general admiration, and self-gratulation with every patriotic Englishman, and it is only within the last few years, that a note of warning has been sounded, and that we have become startled into serious inquiry by prophetic declarations from geological *savans*, and other high authorities in such matters, as to the probable early exhaustion of the English Coalfields. In short, their present produce of 100,000,000 tons a-year and the certain rapid annual increase of these returns, sternly assures us that we are fast consuming our national capital—which, can never be replaced.

Under such portentous circumstances as these, surely any information having a tendency to obviate a domestic disaster of this kind,—even although it may not arrive at a crisis for a century or two beyond the predicted period,—must be hailed with a general and hearty welcome. Well indeed, would it be,

were Governmental aid, scientific acumen, and the requisite powerful appliances characterising the present age of progress, to combine energetically, in throwing open the golden gates of our concealed treasures. That such *exist*, we know, to what *extent*, remains to be ascertained.

In the course of the following explications, it has been shown, that several trials for Coal, which have been made from the surface of formations more immediately superincumbent on the Coal Measures, have proved eminently successful; and it has also been essayed to demonstrate, that whenever other such efficient experiments, are made further out in the wide field of discovery specially, and circumstantially, pointed out, that there are most encouraging (geological) reasons for believing, they would, not unfrequently, be productive of similar happy, and pregnant results. And, then, great as is England's prosperity—mainly emanating from her teeming Coalfields—she must, inevitably, continue rapidly advancing in her career, until she becomes one City—and that, the *City of the World*.

J. H.

LONDON, *January 1*, 1866.

THE Earth from her deep foundations, unites with the celestial orbs, that roll throughout boundless space, to declare the glory and show forth the praise of their common Author and Preserver ; and the voice of natural religion accords harmoniously with the testimonies of revelation, in ascribing the origin of the Universe to the will of one eternal and dominant Intelligence—the Almighty Lord and Supreme First Cause of all things that subsist ; the same yesterday, to-day, and for ever, before the mountains were brought forth, or ever the earth and the world were made, God from everlasting and without end.—*Bridgewater Treatise.*

ON THE
EXTENSION OF THE ENGLISH COALFIELDS
BENEATH
THE SECONDARY FORMATIONS,
ETC.

CHAPTER I.

COAL—THE MAINSPRING OF OUR NATIONAL PROSPERITY :
ITS PERMANENT AND ECONOMIC SUPPLY OF PARAMOUNT
IMPORTANCE.

THE British Nation may, unquestionably, be said to constitute a monument of unrivalled constitutional greatness and splendour, of civilization and freedom, alike the admiration and envy of the world. Raising its stately proportions at the head of the great European Confederation, it appears to the enslaved, and the benighted of all the earth, as a beacon of hope—a radiant pharos towards which millions of straining eyes are turned for liberty and enlightening advancement. And it is no less true, that this admirable fabric is not only virtually founded on the well-stored Coal formations of the British Isles, but, that the material elements of

its construction were mainly derived from their pregnant and precious product—*Coal*, well said to be one of the most useful of all the precious productions of the earth which it has pleased the Almighty to provide for the use of man.

It behoves us, then, as we value our pre-eminent position, and our Heaven-entrusted mission—nay, our very existence as a great and independent community—to look well to the foundation rock of our abounding prosperity.

As our various national resources have continued to increase in vigour and magnitude, and industrial enterprise has daily become more and more largely developed, so, in a perpetually increasing ratio, has been the drain on the invaluable deposits of our great carboniferous storehouses—in fact, the consumption of Coal at the present period is altogether unprecedented. Nearly 100,000,000 tons are now annually raised to meet this demand in various quarters, the money value of which, under existing conditions, may be fairly taken as £25,000,000 at the pit's mouth. This yearly extraction of mineral is the produce of about 4,000 Collieries, employing about 260,000 persons, who, together with their families, will probably represent upwards of one million of people dependent on this branch of mining industry. And this is exclusive of labour necessarily expended in the shipment and conveyance of the Coal, both for domestic and foreign consumption. London alone consumes

about 6,000,000 tons annually. In 1850 our coasting vessels conveyed upwards of 9,360,000 tons to various ports in the United Kingdom; and 3,350,000 tons were exported to foreign countries and the British possessions. Our foreign exports now amount to more than 7,000,000 tons annually. The consumption of Coal (and Coke) by ocean steamers, railway engines, gas works, large manufacturing establishments, and for other domestic purposes, is yearly enormous, and rapidly on the increase.

There are about 1,000 blast furnaces built, or in course of building, making yearly fully 5,000,000 tons of pig iron, of a money value of—say, £14,000,000, but capable of an immense increased production, should the position of the trade allow of it. The money worth of the Coal and pig iron produced in this kingdom, taking the value of the former at the pit's mouth, reaches the immense annual total of £40,000,000 sterling.

Our exports of iron, machinery, and cutlery in declared value at the Customs amount to £5,100,000, whilst our imports of iron amount to only £35,000—nearly the whole of this amount being paid for Swedish iron.

We must not be unmindful that these great smelting establishments, in order to meet the vast and growing demand for iron rails, locomotives, houses, churches, ships, &c., are now constantly augmenting in number, which, with other demands,

too obvious to particularise, will tend to increase immeasurably the present consumption of Coal.

In short, astounding as are the statistical facts just enumerated, they assume a still more transcendent and portentous importance when viewed in relation to the future, especially as regards the far-stretching mechanical energies, commercial movements, and spirit of universal enterprise characterising this powerful and populous country.

CHAPTER II.

PROBABLE EARLY EXHAUSTION OF OUR NORTHERN AND
MIDLAND COALFIELDS.

To investigate, to develop, to conserve with jealous care this grand element of internal strength and prosperity—the *primum mobile* of our multitudinous and world-wide progressions—cannot but be considered as sacred duties by every man possessed of a single spark of patriotism. Far be it from the writer of these pages to exhibit any unnecessary prominence in sounding the tocsin of alarm; but it were impossible for any one at all conversant with the existing facts and prospective bearings of this subject, not to entertain some serious forebodings as to the permanent capabilities of our English Coalfields.

The many and somewhat laboured calculations which, in order to arrive at some reliable and conclusive information on this vital point, have been entered into by men well versed in such matters, have commonly resulted in but very discouraging declarations.

Mr. Bakewell, than whom a more acute and accurate observer or a sounder practical geologist never entered the field, in descanting on the bituminous deposits of the great northern tracts, re-

marks, that the period is not very remote when the Coal districts which at present supply the Metropolis with fuel will cease to yield any more. From data derived from the correctly-ascertained number and extent of the Coalbeds of Northumberland and Durham, it has been calculated that the Coal in these counties will last but 360 years; for although there are as many as forty distinct seams of Coal in this field, but only eighteen of them are considered workable, or sufficiently thick to remunerate by their produce.

Another eminent authority, Mr. Taylor, observes, that notwithstanding the enormous annual produce of the northern field, it is a very moderate calculation of its resources to suppose that the present supply can be kept up through the next four centuries. The trade has been in existence for upwards of six centuries. Mr. Bailey, in his "Survey of Durham," states that one-third of the Coal being already got, the Coal districts will be exhausted in 200 years.

The annual production of Coals by most of the pits in the North of England is very large. The Staveley Collieries, in this respect, are remarkable. The Seymour Pit produces 1,000 tons of Coal per day.

It has been computed that at the rate of one hundred million tons a-year consumption, our Coalbeds will last us for 800 years to come.

We have already drawn from our choicest mines a far larger quantity of Coal than has been raised

in all other parts of the world put together, and the time is not remote when we shall have to encounter the disadvantages of increased cost of working and diminished value of produce. The quantity of Coal yearly worked from British mines has been almost trebled during the last twenty years, and has probably increased tenfold since the commencement of the present century.

“By combining the known thickness of the various workable seams of Coal, and computing the area of the surface under which they lie, it is easy to arrive at an estimate of the total quantity combined in our Coal-bearing strata. Assuming 4,000 feet as the greatest depth at which it will ever be possible to carry our mining operations, and rejecting all seams of less than two feet in thickness, the entire quantity of available Coal existing in these islands has been calculated to amount to about 80,000 millions of tons, which, at the present rate of consumption, would be exhausted in 930 years ; but with a continued yearly increase of two and a half millions of tons, would only last 212 years.”*

It is generally admitted that 200 years will be sufficient to exhaust the *principal seams* of the Newcastle-on-Tyne district, even at the present rate of working. If the production should continue to increase as it is now doing, the duration of those seams will not reach half that period !

* Sir William Armstrong's Inaugural Address, Newcastle, 1863.

From the extreme importance of this division of our subject, a few additional estimates of a minuter, though similar character to the above, may not be unacceptable. The whole area of known Coal-fields in England, Wales, and Scotland, exceeds 4,000,000 of acres, or 6,250 square miles; that over the area there is an average thickness of Coal which cannot be estimated at much less than fifteen feet, or five yards, and that therefore the estimated quantity of Coal is equivalent to a bed whose surface occupies 31,250 square miles, one yard thick. The 80,000,000 tons annually consumed at present would be equivalent to an area of nearly fifty square miles, one yard thick; and thus an estimate of *six hundred years for the duration of our Coals*, at the present rates of consumption, would seem to be justified.

One would imagine that such gloomy conclusions would induce the utmost care to be taken in economising every particle of the mineral; yet the very reverse would appear to rule; for Mr. Holmes, in his "Treatise on Coal Mines," states the waste of small Coal at the pit's mouth to be one-fourth of the whole! The waste in the mines is computed to be one-third. These are facts which alone loudly call for some sort of legislative interference.

As regards the more southern English Coalfields, Mr. Bakewell, after entering into some elaborate disquisitions on the capabilities and demands of

each, concludes by remarking that we may thus anticipate a period, not very remote, when all the *English* mines of Coal and Ironstone will be exhausted ; and, continues he, “were we disposed to indulge in gloomy forebodings, like the ingenious authoress of ‘The Last Man,’ we might draw a melancholy picture of our starving and declining population, and describe some manufacturing patriarch, like the late venerable Richard Reynolds, travelling to see the last expiring English furnace, before he emigrated to distant regions.”

CHAPTER III.

GEOGRAPHICAL EXTENT AND MATERIAL CAPACITIES OF
THE KNOWN ENGLISH COALFIELDS.

FROM the discouraging and portentous picture just contemplated, our attention may now be directed to one of a consoling and reassuring aspect. It must be borne in mind that the above gloomy conclusions have been derived solely from calculations made on the *explored* Coal seams of our *known* or isolated Coalfields. The superficial limits, or boundaries, of these irregular areas of Coal Measures are, for the most part, composed of lower secondary formations; the New Red Sandstone series vastly predominating, and amid which the Coalfields are dispersed like islands in the ocean.

It was formerly very commonly believed that the Coal and its concomitants were thus, also, *sub-isolated* masses "cut off" by the surrounding foreign deposits in question; but certain subsequent actual trials made a little beyond these natural borders, resulted in successes which have tended greatly to dispel such illusions; proving, as they do, that these noble mineral repositories merge beneath at least the Permian system. In order, then, the stronger to justify the position we are desirous of establishing—that the known Coalbeds are not only thus

locally extended, but in all probability have a vast geographical range beneath the secondary and even more recent formations of the country, it becomes desirable to glance at the physical character of the principal Coal tracts under consideration, especially as to their extent, and vertical dimensions.

Although the South-Welsh-Coalfield does not exactly come within the range of the present category, it merits our first attention in an inquiry of this general character. The Coal Measures of this mineral storehouse are on a magnificent scale, both as to extent and thickness. Their average length and breadth are computed at about 1,000 square miles, and in the centre of the basin are at least 12,000 feet deep. They contain 100 seams of Coal, 25 workable, with an abundant supply of Ironstone. There are 12 distinct seams of Coal, from 3 feet to 9 feet thick each; which together make $70\frac{1}{2}$ feet; and there are 11 more, from 18 inches to 3 feet, which make $24\frac{1}{4}$ feet, besides a number of smaller seams, from 12 to 18 inches, and from 6 to 12 inches in thickness, not calculated upon. The workable seams contain 95 feet of Coal, in 23 distinct strata, which will produce in the common way of working 100,000 tons per acre, or 64,000,000 tons per square mile. The Coal at the east end of the basin, from Pontypool to Hirwain Furnace, is of a coking quality; from thence to Bride's Bay, at the opposite extremity, the strata yields Stone Coal, or Anthracite; on the south side of the basin the

Coals are principally of a bituminous, or binding quality. The principal part of the Coal lies under Glamorganshire. This carbonaceous group of strata reposes on the Millstone Grit and Carboniferous Limestone, and by elevated ranges of which it is almost entirely surrounded.

Durham and Northumberland Coalfield constitutes an area of about 700 square miles, with about ten seams of workable Coal, collectively making thirty-six feet of Coal. Dr. McNab computes that one square mile in this tract, of an average, is equal to the consumption of a year. These Coal Measures attain a thickness of 1,500 to 2,000 feet. They rest on Millstone Grit (with Shales and *Coal*) 400 feet, Yoredale Limestone (with Shales, Sandstone, and thin *Coal*) 500 feet, Scar Limestone (with shales and *Coal* seams) 1,000 feet, Tuedian Limestones, Sandstones, and Shales 1,000 feet.* The *Millstone Grit* series constitute a magnificent ridge from Barrel Edge, south of Matlock, to the borders of Scotland, joining the Cheviot Hills in the north. It is called the Penine Chain, and is the great water-shed of Northern England.

The figure of this immense Coalfield is very irregular. From its southern extremity, a little beyond the Tees, at Staindrop, Durham, to its northern limits, near Alnwick, Northumberland, it has an

* These, and some other statistical data, have been derived from an excellent work on "Fossil Fuel and Coal Trade of Great Britain."

extent of about seventy miles. It is bordered on the west by the outcrop of the Lower Carboniferous beds, before enumerated, forming the mountainous range, in which the great lead-mining districts of the North of England are situated. From a little south of Alnwick to the estuary of the Tyne, near South Shields, the Coal extends along the coast line, dipping, indeed, under the German Ocean; from the neighbourhood of Shields to that of Darlington it disappears to the east beneath the Permian rocks, and from the surface of which it is here occasionally wrought. At the important Colliery of Hetton, in the county of Durham, the shafts are sunk through twenty-six fathoms of the Magnesian Limestone to the Coal Measures.

Besides the carbonaceous tracts above indicated, there are various unexplored localities which future research may add to our present Coalfields. These are mainly situated in the elevated regions of the *Lower Carboniferous Series*, known to contain some valuable seams of Coal and Ironstone. The Collieries of Brenkburne and Plashetts, in Northumberland, are in these measures. The Nodular Ironstone, found in abundance at the former, contains 48·62 per cent. of metal, and quarries of excellent Limestone and Freestone are worked on the property.

The important Coalfields of Yorkshire, Derbyshire, and Nottinghamshire, so called, as extending into these counties, but constituting one continuous extent of formation, stretch in length from

Nottingham to Bradford, a distance of upwards of sixty miles in a straight line, and are on the average hardly less than eighteen miles in breadth. The Coal Measures of Derbyshire and Yorkshire occupy an area of from 700 to 1,000 square miles, and contain fifteen workable seams, having an average thickness of forty feet of Coal. The upper, middle, and lower strata of the latter county present a thickness of from 2,000 to 3,000 feet, and the lower series, including the Millstone Grit, Yoredale, and Scar Limestones, with Coal and Shales, have an additional aggregate thickness of nearly 3,000 feet. To the east and south-east these extensive Coalfields are bordered by the Permian deposits, under which they dip, and to the north and west by the lofty moorlands of the Millstone Grit.

The Lancashire Coalfield is separated from the above by these bleak Grit ranges. It has an area of about 230 square miles, with an average thickness of sixty feet of Coal. The Lower, or Ganister Coalbeds, have shaley roofs, containing marine shells, *like the equivalent strata of Yorkshire and Derby*. The extreme western portions of these Coal Measures and Lower Carboniferous beds, having a thickness in the aggregate of about 12,000 feet, merge beneath the New Red Sandstone, at a short distance from Liverpool, and probably continue their course under it until they join the Flintshire Coalfield, forming the southern shore of the estuary of the Dee, beneath the bed of which, consisting of New Red Sandstone,

two or three valuable delphs of Coal were discovered by boring, several years ago.

In South Staffordshire the area of the Coal has been estimated at ninety-seven square miles, its average thickness forty-eight feet. In North Staffordshire the area of Coal is computed at seventy-five to ninety square miles; workable seams, twenty-two; average thickness of Coal, ninety-four feet. Some authorities have estimated the area of this field as comprising from 40,000 to 50,000 acres of thick (ten yards) Coal. It is bordered on all sides (except the north-eastern, where Millstone Grit appears at surface) by the Upper and Lower New Red Sandstone. These formations also surround the South Staffordshire Coalfield, with the exception of an isolated mass of Upper Silurian Limestone on the eastern limits.

The Coal Measures of these well-stored "Fields" have recently been proved to pass beneath the New Red Sandstone series. They here rest immediately on the Silurian rocks, without the intervention of the Old Red Sandstone, Gritstone, or Mountain Limestone. But here the Coal Grit, with coarse Limestones, including Shales, Clunch, &c., in numerous beds, are interstratified with the Coal, so as *fully to represent the whole carboniferous system.*

The ten-yard Coal, and several other workable seams, exist in the vicinity of Bilston, Dudley, and Walsall, but North Staffordshire has twice the thickness of workable Coal.

Shropshire Coalfield, includes Coalbrook Dale and the Plain of Shrewsbury; these, taken together, may make eighty or ninety miles of Coal, interspersed through a thickness of 12,000 feet of Coal Measures. These insulated Coalfields are, for the most part, bordered by the New Red Sandstone.

Warwickshire Coalfield extends from Tamworth to near Coventry, twenty miles; the average breadth being about three miles. It contains eight workable seams of Coal, the average thickness of which amounts to twenty-six feet. Red Marl (Kuper) bounds the whole of this field, excepting its southern portion, where it is bordered by the Lower Red Sandstone, trending southward to within a short distance of Warwick, and affording a reasonable prospect of reaching the Coal Measures from its surface at comparatively shallow depths.

The Leicestershire Coalfield extends north-east and south-west of the town of Ashby-de-la-Zouch, making together at least thirty square miles. Mr. Mammett's section of this field presents us with ninety-three alternations of strata included in a depth of 475 feet. It affords five beds of Coal of different qualities, averaging about three feet in thickness, and occurring at intervals about the "Main" and "Nether" Coals, which are in contact, and together fourteen feet in thickness. At Moira Colliery, on Ashby Wolds, the floor of the main Coal lies at the depth of 744 feet; and in the Hastings Pit, the main seam reposes on a stratum

of Fire Clay about 1,000 feet below the surface. There are ten workable seams of Coal.

This isolated area of Coal Measures rests on the Cambrian and Silurian Rocks of the neighbouring Charnwood Forest, and is entirely bordered by the Red Marl (Kuper) under which they incline, and trend away beneath it—in full development, as proved at Bagworth Collieries, &c.—to the southward.

South Gloucestershire, or Bristol Coalfield, lies to the east of the city just named, and may be said to be about twelve miles long, and three miles in average breadth. It is bordered on the north and north-east by belts of Millstone Grit and Mountain Limestone, the Red Marl (Kuper) skirting it in every other direction, beneath which, and occasionally the superincumbent Lias and Oolites, it dips to the east and south-east. The Coal Measures shortly appear again at surface, in the isolated patches which constitute the Somerset Coalfield, and form a curved tract, stretching upwards of twelve miles in length, and being about three miles over in the widest part. They are almost everywhere bordered by the New Red Sandstone, commonly dipping, also, immediately under the Lias deposits.

The eastern extremity of the Coalfield, near Frome, approaches near to the Chalk ranges of Salisbury Plain, and is bounded on the south by a narrow strip of Carboniferous Limestone, which becomes much wider in its course to Weston-Super-Mare.

The several Coal tracts of Gloucester and Somerset may be said to constitute one field, occasionally to the southward, concealed by attenuated New-Red-Sandstone Liassic, and Oolitic beds. It presents an area of about 150 square miles, containing twenty workable seams, giving an average thickness of seventy-five feet of Coal, interspersed through a series of Coal Measures, computed to be here, as in Staffordshire, 5,000 feet in thickness.

The striking criteria now presented, furnishes abundant testimony of the vast productive capabilities, and magnitude, of our superficial Coal Measure deposits ; they not only constitute the predominant geognostic feature of Northern England, but, it will also be seen, can be traced, progressing *en masse*, as it were, with evident modifications, into the very heart of the great undulating plain of New Red Sandstone, mainly occupying the Midland Counties ; and no geological evidence is therein discoverable which would for a moment warrant a belief, that they do not also, constitute an important sub-Carboniferous area, in the South and South-eastern Counties, traversed by the more recent Formations.

CHAPTER IV.

ON THE PROBABLE EXTENSION, BY GEOLOGICAL INDUCTION,
OF OUR COALFIELDS BENEATH THE NEWER FORMATIONS
OF THE MIDLAND AND SOUTHERN COUNTIES OF THE
KINGDOM.

It were impossible to overrate the prospective importance of this particular division of our subject ; and in treating it with all possible brevity, it merits our earnest attention to considerations, both of a comprehensive and local character, indispensable to its adequate elucidation.

The evidence now adduced as to the superficial extent, capacious and invaluable significancy of the chief English Coal repositories, constitutes a very striking basis, on which we may confidently proceed to ground our inquiries.

The denuded or exposed tracts of our Coal Measures afford ample demonstration of their voluminous body, and their vast continuous extent, in a direct line, through the Northern and Midland districts of this country. For instance, from the northern extremity of the Northumberland Coal deposits, south of Berwick, to their most southern point, on the Tees, the distance is about seventy-five miles. The Coalfields of Yorkshire, Nottingham, and Derbyshire, constituting one uninterrupted extent of formation, stretch in length from Nottingham to

Bradford, a distance of more than sixty miles, in a straight line, and average nearly eighteen miles in breadth. In the opinion of Mr. Conybeare, the measures of this important field so closely agree, in their direction, inclination, and character, with those of Northumberland and Durham, that he considers them a re-emergency of the same strata from beneath the covering of Magnesian Limestone, which conceals them through so long an interval. All this, very palpably exhibits, a conterminous advance of these Carboniferous formations on their trending line southward, abundantly warranting a belief in their indefinite extension in that direction. In taking a more general view, we find that the "total area of the English and Welsh Coalfields is estimated at between 2,700 and 3,000 square miles."

But whatever may be the amount of the supplies of Coal in reserve, treasured up in these noble fields, it obviously, does not in the least detract from the vast importance of forthwith availing ourselves of every possible information and means for the discovery and development of new deposits of the precious mineral, and which we are so desirous of demonstrating, do certainly exist, at accessible depths, beneath immense areas of the Secondary formations.

Nevertheless, strange as it may appear to the more initiated, a disposition is very commonly evinced by those who rejoice in the popular acknowledgment of their geologic lore, to condemn, on

the grounds of their own scientific views or acquisitions, all attempts at searching inquiries or actual operations, that may be adventured with a view to the discovery of Coal in any of the unexplored tracts adverted to, either in Central or Southern England. Whilst, however, the scientific veto complained of stays the hand of the experimenter, so long, it is obvious, will the adverse opinions broached on this pregnant subject remain inviolate; and yet, after all, from the very nature of the inquiry, this great problem can alone be solved by adequate and well-directed practical efforts.

In proceeding to examine how far the discouragers of these most important enterprises are, on geological principles, justified in their avowed opinions, as above intimated, it may be well, first, to inquire, with some particularity, into the question of the subterranean continuation and accessibility of the Coal Measures beneath the Red Marl (Kuper) and New Red Sandstone (Triassic) of the Midland Counties.

In an address on this subject by Professor Jukes, delivered before the British Association, held last year at Birmingham, he admits that large tracts of Coal Measures, containing good beds of workable Coal, are concealed under the Red Rocks of the Midland Counties; but the drift of his argument is to disparage the search for Coal beneath them, on the grounds of his assumption of their great thickness, and also that the disturbing and denuding

forces he so unsparingly invokes may have occasioned their absence from many tracts beneath the New Red Sandstone.

In the outset, Mr. Jukes pictures a "Carboniferous sea," studded with islands, formed of the Lower Paleozoic rocks "stretching across the Midland Counties from Wales, through Shropshire, South Staffordshire, and Warwickshire, into Leicestershire, and perhaps further to the east and south. Subsequently, this land is *depressed* beneath the water in which the Coal Measures were formed, and the uppermost beds of that group, spread in *level sheets* over that land, covering the *whole district* with Coal Measures from *South Wales into Scotland*," a few islets still peering through this Carboniferous ocean. "There was, then, a period of disturbance and denudation, in which the Coal Measures were rent and faulted, and certainly a good deal eroded. Upon this eroded surface the Permian beds were deposited, no proof of any large mass of Permian beds being deposited on other rocks than Coal Measures in the Midland Counties, though in Yorkshire and Durham it rests on the Millstone Grit." We are next informed that "a *great* disturbance and destruction took place *after* the deposition of the Permian beds," separating the Coal Measures into isolated patches, forming our present Coalfields, denuding the Old Red Sandstone Rocks of South Wales and its borders of their mantle of Coal Measures, and tearing away the stupendous arch

formed by these Carboniferous deposits over the Derbyshire and Yorkshire hills."

Thus from seas pacific, we are gradually drifted into waters of intense turmoil and overwhelming power!

Unquestionably, however, not only the formations above referred to, but all subsequent depositions, up to the most recent, have been more or less subjected to the great transposing and denudating agencies alluded to; they, in short, are the instruments of consummate power and wisdom, employed in the production of most beneficial and effective results. And, as we proceed, we trust to be able to render it abundantly apparent that so far from being productive in a general sense of "untoward conditions," they will prove to be our most efficient auxiliaries in fortifying the position we aim to establish.

It, nevertheless, not unfrequently happens that these grand agencies of nature are too liberally evoked and over-taxed, for the purpose of meeting the requirements of some favourite hypothesis of speculative scientific minds, and in the present instance the learned Professor would appear to have wielded them somewhat too gratuitously and profusely—has, in fact, played sad havoc with hill and dale, mainly of his own creation! And considering the *mountains of carbo-debris* which must necessarily have resulted from these Cyclopien rendings, the dire effects of a veritable cataclysm, we are naturally led to ask, *what has become of it?*

In the immediately succeeding Permian deposits even, we see not a trace of it! Nor can we discover that it has been swept away into the Lias beds, nor amongst the Oolitic ranges; nor is it intermingled with any of the succeeding sedimentary beds up to the very climax of all, the alluvium! Verily, it must have gone to sea.

We are most of us familiar with the results of comparatively slight debacles, and have witnessed the wreck and ruin of rocky masses scattered along their pathway, and it were impossible to conceive that the intense perturbations we have been contemplating would have left no such tangible evidences of their wide-spread sweeping devastations. And yet where are they?

In the briefly-sketched synopsis of the paper in question it will be seen that as extensive an area of Coal Measures has been laid down "in level sheets" over the body of the kingdom as we could well desire; and though alleged to have been a "good deal" eroded, that point can alone be proved under the Red Rocks by the experimenter. This vast field is believed to have received at the close of the Carboniferous period its requisite complement of "rents and faults," with which, beneficent Nature parcels out the Coal and its concomitants into workable compartments, by staunching here and there the superfluous flow of waters; and, moreover, many of these vast dislocations subserve a strikingly provident purpose, in repeatedly *elevating*

the strata in the direction of their general dip, thus keeping them within the reach of the miner throughout immense tracts of country. In England, the sedimentary deposits generally incline slightly to the south-east.

The Coal Measures in question are covered by the New Red Sandstone as with a mantle, and our author reminds us that the adventurer must be prepared to "sink boldly 500 fathoms before reaching them!" This, probably, has especial reference to the Triassic districts, the maximum thickness of the Permian being estimated at between 300 and 400 yards. Well, formidable as these difficulties appear on the face of them, we have only to invoke the aid of the ready handmaid "denudation," and forthwith her *sweeping* evolutions will cause them to vanish as indubitably, perhaps, as have the fragmentary products of her above cited operations on the "*Backbone of England*."

The isolated, irregular areas forming our present Coalfields are authoritatively considered to be notable examples of this denudating agency, not, we maintain, by cutting them off below, but by disclosing them to the day, on the removal of foreign depositions. Possibly many of these Coal Measure patches may never have been overlaid by the New Red Sandstone; and it is very probable that in districts where certain members, or even series, of the latter now prevail, certain of its more characteristic groups may never have been deposited

at all, and of course such may have been the case with every other description of sedimentary formation.

Central England is chiefly occupied by the Red Marl—occasionally with Sandstone and Gypsum—(Kuper). This division is also found in Cheshire, the great Salt Works of Nantwich being in the *uppermost* beds of the New Red Sandstone. But recently, to the surprise of most geologists, a splendid bed of solid Rock Salt, eighty feet thick, has been discovered by boring, at Middlesboro', near Newcastle, in, it is said, the *Lower* Red Sandstone series—Permian; the borers having penetrated it to a depth of above 1,300 feet before reaching this most valuable saliferous deposit.

The lower, or Permian beds, form the surface group throughout several large areas of the Northern and Midland districts. For instance, from the mouth of the Tyne to Nottingham the Magnesian Limestone, Red Sandstone Marls, and Conglomerate, constitute the superficial series, and beneath which the Coal seams of the adjacent field dip, and are there occasionally wrought.

Some thirty years ago a valuable estate in Durham was pronounced to be devoid of Coal, *because it was situated on the Magnesian Limestone*, and might have been sold under this opinion, but that the celebrated practical geologist, Dr. William Smith (father of geology), showed the falsity of the reasoning, reported favourably of finding good Coal in

abundance beneath the property, and advised the proprietor to work it. That estate is now the centre of a rich and well-explored mining tract, *all situated beneath the Magnesian Limestone.*

Permian rocks border a greater part of the Staffordshire Coalfield. The Magnesian Limestone is absent, but the Upper New Red *Bunter* stretches away from its northern extremity, in the direction of Stafford, until it joins the Permian beds which fringe the Potteries Coalfield, near Burslem and Stone-upon-Trent. In all probability this extensive tract, intervening between the two fields, is occupied by subterranean Coal Measures, as on Cannock Chase, where a rich Coalfield has lately been won by sinking through the Upper New Red Sandstone.

The thick (ten yard) Coal of South Staffordshire has been recently found at the Earl of Dartmouth's sinkings, near West Bromwich, beneath the *Permian* formation.

As a further proof of the extension of the Staffordshire Coalfield beneath the New Red Sandstone—in this instance to the *south* of the field proper—we may state that for some time borings have been carried on through the Red Rocks of the Halesowen Valley, in Worcestershire, with a view to test the existence of Coal there at a moderate depth. Mr. G. S. Dawes has had the co-operation of other owners of mineral property in carrying on these experiments ; and in a letter to the *Birmingham Daily Post*, September 30th ult., he says : “ It

will be a satisfaction to some of your readers to learn that the thin stratum of Coal known to the colliers as the 'Black Ring' was passed through yesterday at the Manor House; and as this is a well-defined and characteristic measure in the thick Coal series, a more accurate opinion may now be formed as to the position of the ten-yard seam, which will be met with at about 500 feet from the surface, or within a few yards of that depth, more or less, and will prove that certain learned geologists have been very inaccurate in their opinion upon this point."

Permian beds constitute the southern borders of the Warwickshire Coalfield, and extend in a belt of about ten miles broad, due south, to within a short distance of Warwick, affording thereon considerable facilities for explorative operations.

The upper series of Red Marl and Rocks (Kuper) occupy the intermediate space of about twelve miles in extent between the southern limits of the extensive Derbyshire Coal tract and the northern borders of the Leicestershire Coalfield. The measures of the latter, as they approach the Primary and Clay-slate ranges of Charnwood Forest, appear to have become somewhat attenuated as compared with their aggregate thickness in the North of England, a circumstance very common to similar dispositions elsewhere of the several class-formations. But these Carboniferous deposits seem to be recovering their wonted volume after passing the anticlinal line

of the above Siluro-Cambrian and Syenitic Rocks near their western termination. This fact has been pretty amply demonstrated by the Colliery works in extensive operation at Bagworth and neighbourhood, situated about nine miles to the south of the denudated Ashby-de-la-Zouch Coalfield, being at least that distance from its junction with the Kuper series, and which were long considered *there* to terminate the Coal Measures in a southern direction.

Viscount Maynard, however, on the faith of the sub-trending of the measures to the southward, made, many years ago, the bold experiment of boring for them on his Bagworth estates, and after upwards of three years' incessant labour, succeeded in the discovery of a richly-stored new Coalfield, and some of its valuable seams are now being extensively wrought. At this spot, so far from the Ashby Coalfield, although the sinkings were commenced in the uppermost (Kuper) beds of the Red Marl formation, the whole series have proved to be only 105 yards thick to the Coal Measures, thus showing the absence of the Permian and the trending of the Coal and its concomitants to the southward, at moderate depths, beneath the Upper New Red Rocks.

Shortly after these eminently successful results, the writer commenced a trial for Coal on his property, situated several miles to the south-east of the above Colliery, and on the Lias formation; the experiment being mainly induced by the occurrence

of a large, well-defined fault in the vicinity, bringing up, occasionally near to the surface, fragments of Coal and all its concomitants, and which *uniformly characterised it*, as he proved by numerous trial-pits put down on its line of bearing, for a distance of about three miles. A similar fault passes through the Lias of Paulton Hill, Gloucestershire, being likewise filled with fragments of the subjacent Coal formation. This trial, by sinking and boring, was carried on unremittingly for upwards of three years, and was extended to a depth of about 330 yards. In passing through above forty yards of hard stone-hands, characteristic of the Lower Lias, the progress was more than ordinarily slow and tedious. These calcareous strata were immediately succeeded by an attenuated deposit of Red Rock, and which, apparently, reposed directly on Coal Measures, a series of indurated black and gray shaley beds thoroughly impregnated with coaly matter. After passing a considerable distance into them, the borings were suddenly terminated by the fraudulent introduction (despite of every precaution) of iron and steel into the boring-hole, some of which was extracted, but the main body resisted all attempts to remove it. The *geognostic* developments of the operations were, as above intimated, of a highly satisfactory character.*

* These works were situated on the Manorial Estate, within a few hundred yards of Billesden Coplow House, the residence of the Proprietor.

By the disquisitions already entered into, it will be seen that from the extreme northern point of England we have a well-developed concatenation of Coalfields proper, extending directly south into the most central districts of the country ; and also, that we are abundantly warranted in the belief that an actual junction, more or less, exists of the several Coalfields, under cover of the Permian and Triassic groups, and which may not uncommonly be reached at moderate depths, many members, and even entire series, of the Red Rocks being frequently absent from their assigned geological positions. And in thus viewing the geographical extent of these Coal Measures, it would be at variance with analogous conditions, not to conclude that they have a vastly more extended range under the newer geognostic formations of the kingdom ; and if even to the south or south-eastern coast, this additional distance would be of much less lineal extent than that of the Carboniferous fields above indicated.

We may, then, it is trusted, with all due confidence, continue our efforts to remove the bars and to unfold the ponderous scroll which more especially envelopes in obscurity the important department of subject matter to which we have now particularly to address our inquiries. The data emanating therefrom may, at any rate, assist in giving a readier clue towards winning the wealth of attainable, untouched Coal, actually treasured up in the capacious bosom of our eminently-favoured island.

It has been truly observed, that the knowledge of the extent of a Carboniferous formation near the surface, or partially proved, even under the covering of younger formations, is not sufficient ground upon which to form an opinion concerning the value of a Coalfield. Those who wish to compare the wealth of different countries, as regards Coal, would arrive at very erroneous results by founding their calculations on the *superficial extent* of Coal Measures in each country, or on the proportion which this superficial extent bears to the surface of the entire country.

We know not if we should be justified in designating our English Coal tracts,—including their supposed sub-extensions—more immediately under review, as a vast Basin, for we have little or no criteria to direct us on that point, in certain local outcroppings of the older rocks on which they are known to repose. Probably they may, by some of the natural phenomena which occasionally depress or elevate strata, exist for the most part as a chain of basins, having their extreme southern links joined to the Coalfields of Northern France.

The appellation of "Coal Basin" has occasionally been given to the German Ocean, on the ground that the Carboniferous strata, which dip eastwardly near the coast, below Newcastle, are the same that are found descending in a contrary direction on the opposite shores of Belgium.

Comprehensively viewed, the grand theatre of our present investigations is, in fact, the area lying be-

tween the northern and western Primary and older Paleozoic districts of England and Wales and the identical German ranges to the south-east, with those of Brittany on the west. Were all the superior sedimentary deposits now occupying—*stratum superstratum*—the intervening space to be swept away down to the Coal Measures, we should behold a profound, expansive valley or basin, with, doubtless, a very undulatory, disrupted, unevenly-disposed contour of surface. Certain of our own extensive Coal tracts, with those of Belgium, Lisle, Mons, Hainault, Aix-la-Chapelle, Conde, Douay, Tournay, and Pas-de-Calais, would, we know, figure there; and may, from analogy, fairly infer a junction of them, or at all events, a vastly-increased extension of the respective fields beyond their as yet ascertained limits. And should even the whole of the above-mentioned area be occupied by the Coal formation, it is but a mere point, as compared with the extent of some Coalfields, and especially that of the Mississippi, which *would cover half Europe*, occupying an area of 200,000 square miles, being the most extensive development of Coal Measures in the world.

The Province of Hainault is said to be richer in Coal Mines than any part of the Continent of Europe. This is a significant fact in reference to the conclusions we are desirous of elucidating. The enormous volume of Coal Measures traversing this division of the north-east of France pretty nearly

approximate, in their extensive superficial area, to the Straits of Dover, being, in the intermediate space, overlaid by Cretaceous, and frequently Tertiary deposits.

Reverting now to the grand Carboniferous area above delineated, as it is actually characterised by its existing geological features, and commencing with the southern extremity, say, of the Warwickshire Coalfield, with a view to direct our investigatory steps towards the Metropolis, or to the south-east, we pass over, at right angles, in ascending succession, a series of formations chiefly trending in narrow zones through the country in a north-east and south-west direction—namely, the New Red Sandstone, Lias, and Oolites—all with gentle inclination disappearing in turn beneath each other, until we reach the Cretaceous deposits; and continuing onwards over these (and the Tertiary of the London basin), we ultimately arrive at their southern escarpments in North-eastern France and Belgium, where we find them (the Chalk beds) actually reposing immediately on the Coal-formations of the extensive basin of the Hainault, &c.—*all* the great sedimentary deposits which we have found interposing geologically between the Coalfields of Central England and its Chalk ranges, having here *entirely disappeared* from their assigned geognostic positions—in other words, have respectively thinned out; and it is impossible, in our present state of information, to divine whereabouts in the line of

march above intimated, the several first-cited Secondary formations come to their southern termination, after respectively disappearing to the south-east, or what their thicknesses where present; and hence the absurdity of assuming even their sub-existence, or defining their vertical dimensions, in any such concealed positions, ere actually tested by some effective practical operations.

Most erroneous conclusions are also commonly arrived at from calculating the thicknesses of the great Secondary zones, by the appearance of their basest edges at surface. These very often occupy considerable tracts of country; and having but a very slight general inclination, it is next to impossible, from such data, to assign a given thickness to any extent, of any one of these class-formations, and hence the very great discrepancies in the estimates of their individual and aggregate thickness, as given by various geological writers.

Ideal geological sections are at best, but very faithless representations of expansive stratified deposits as they really occur in nature. Yet some writers would seem to assume a uniform sequence of secondary deposits—like the coats of an onion—and to expect as much uniformity in the distribution of detritus as in the leaves of their own volumes. Whereas, no geological fact is more universally apparent than that the sedimentary deposits have all been subjected to innumerable modifications and displacements. Had, for instance, the opinion of

these theorists been solicited as to the probability of reaching, by sinking or boring, the New Red Sandstone from the middle Oolitic beds, near Northampton, they would, as by common consent, have taken up their parables and said, "An acquaintance with the simplest principles of geology positively decides any such attempt to be fruitless altogether."* And yet, forsooth, the simple operations of the miner have there discovered that identical arenaceous deposit (with a strong salt spring therein), although it emerges from beneath the Lias escarpment at a distance of about twenty-six miles northward from Northampton.

Dr. Buckland, after visiting the site of the above discovery, observed, in a letter to Mr. Cooke, the proprietor of the estate on which the operations were conducted: "I believe the lower beds now penetrated to be the gray and sandy beds of the Red Marl formation (the *Kuper* of the Germans), in the vicinity of which there is usually salt." And, we have the high authority of Sir Roderick Murchison for believing that this division of the New Red Sandstone series is of very inconsiderable thickness in the Midland districts, he having traced it from the borders of Gloucestershire, through Worcestershire, into Warwickshire, and never found it exceed

* Dr. Richardson's statement; acquiesced in by Mr. Mackworth, and other authorities, and which opinions, were publicly controverted at the period by the Author.

forty feet in thickness ; and in all probability the New Red Sandstone formation, wherever it may exist under the superimposed Lias and Oolites, is for the most part (as proved in the West of England, &c.) but of a very attenuated character, at all events, as compared with its geognostic estimate.

This formidable experiment for Coal, made about twenty-five years ago, is the most southern one of any magnitude as yet attempted. Though the site of the trial at Kingsthorpe is in the very heart of the Oolitic ranges, and in the most central part of the kingdom, where the Secondary formations are considered to attain their maximum thicknesses, it nevertheless disclosed some notable mineralogical features, certainly as unlooked for there by most profound geologists as the Coal itself. Through the exhaustion of funds, the works were suspended at a depth of only some 150 fathoms. Before reaching which by about twenty-five fathoms, the writer's opinion was solicited as to the prospects of the undertaking, and from the sectional developments up to that period, he was led to express a strong belief that they were in close proximity to the New Red Sandstone, the discovery of which was soon after announced to him, and confirmed by Dr. Buckland's visit to the works. The strong spring of saline water issuing from the Kuper beds yielded on analysis, by Mr. Gardner, 372, Oxford Street, London—Muriate of Magnesia, 4 grains ; Muriate of Lime, 8 grains ; Muriate of Soda, 69·50 grains ;

Sulphate of Soda, 48.50 grains—equal to 130 grains in a wine pint of the saline water.

The geognostic developments resulting from the above operations are unquestionably of a very important and encouraging character, as regards the practicability of reaching the Coal Measure series from the surface even of the Upper Secondary formations, in Central England.

Though the succession of the Great geological depositions is never inverted, it must be an extremely rare circumstance to find the series perfect; certain strata are wanting, sometimes whole groups are absent, and at others entire formations have disappeared from their assigned geological positions. As two striking instances of which, we may point to the southward, across the Channel, where the Chalk may be seen resting immediately on the Carboniferous strata, and northward, to the Chalk beds reposing on the Mica-schist of Cushendall, in Ireland, respectively presenting a geognostic hiatus of stupendous character.

These and suchlike fitful phases are, however, but ordinary occurrences in the grand diversified arena of nature, and inseparable from the mighty causes and catastrophes which have operated therein, of which, fluviate action and oceanic currents have been the great and incessant agents in the deposition and transposition of the earth's materials, and, by their denuding effects especially, have imparted to the superficies of the various sedimentary forma-

tions every imaginable degree of difference and incertitude.

“England contains almost all the series (of sedimentary formations) from the south frigid to the north temperate zones, but not piled on one another, as described in the usual geological sections, but overlapping at the edges at different extremities of each other; thus showing, that although some parts were constantly under the sea, receiving new deposits, they were not always the same, but alternately changing, according to circumstances.” Hence, we find their respective development varies considerably in different localities. Mr. Bakewell’s actual investigations induced him to record similar opinions. He says it may be frequently observed that particular beds which occur in one part of a formation, and are considerably developed, cannot be traced even into an adjacent district, or they vary so much in thickness and mineral characters, as scarcely to be recognised. In taking an extensive formation like the Oolites as an example, it is not possible to assign any one part of the range as affording a correct type of all the series in distant or even in neighbouring parts of the range, though we may trace a general resemblance in all the principal beds.

From what has now been stated, it can hardly fail to be seen how little would any one be justified in attempting to deduce, from geological principles, the thickness in the aggregate of any of the geo-

logical formations under consideration, in hardly any locality throughout their whole extent, from their north-eastern extremity on the Yorkshire coast, to their south-western termination on the coast of Dorset. In every district through which they thus range, evidences of extensive denudation meet the eye on almost every hand. The Lias and Oolites have, in all probability, extended northward far beyond their present limits. Outliers of these formations are to be seen in the north of Ireland, the Hebrides, and Northern Scotland.

In some situations in the existing ranges, large proportions of the upper beds have evidently been swept away, and groups, as well as members of the lower series, have doubtless been subjected to the same modifying influences; and, therefore, unquestionably, in numberless localities, judiciously and skilfully selected, the Coal Measures might be reached at, geologically speaking, moderate depths, and with the powerful appliances now at command, both with considerable expedition and profit.

There are, however, other auxiliaries, efficient provisions of nature, which greatly tend to augment our faith in results so important and desirable as those just intimated. These, also, belong to the class of disturbing causes—partial evils for universal good.

It has been remarked that there seem to be three groups in the geological series during the formation, of which signs of extraordinary disturbances appear

—namely, in the Gneiss, and Clay Slates formerly called transition rocks, in the Carboniferous group, and in the Hastings and Green Sands, with other strata, which lie immediately beneath the Chalk formation. Our business, however, for the present, is with the intimated phenomena of the two former groups.

The basis on which Coal Measures rest very commonly presents, as already intimated, a very uneven, distorted contour of surface, or rather *flooring*—firstly, the croppings out to the day of certain—Paleozoic rocks of which it is formed, often constitute the steep and towering basset edges of a Coal basin, as in the South Wales and Forest of Dean Coalfields, where this elevated margin is chiefly composed of Millstone Grit and Mountain Limestone, occasioning the Coal seams over large areas of country to approach very near the surface ; and, secondly, occasionally in other districts, elevations, depressions, and undulations of the older subjacent rocks often produce similar beneficial results, throughout vast tracts of Coal Measures concealed by unconformable newer deposits. But, perhaps, of all such providential phenomena, none are so conducive to the winning and working of Coal seams as the dislocations so numerous and peculiarly intersecting Coalfields, commonly, though not very appropriately, called “Faults.”

“In the secondary causes producing these supposed effects of convulsions having operated at suc-

cessive periods, not blindly and at random, but with a direction to beneficial ends, we see at once the proofs of an over-ruling Intelligence continuing to superintend, direct, modify, and control the operation of the agents which He originally ordained.

Examples of this kind are perhaps nowhere more strikingly afforded than in the instance of those fractures or disturbances, called "faults," which occur in the alternating beds of Coal, Slate-clay, and Sandstone, which are usually associated under the name of Coal Measures. The occurrence of such faults, and the inclined position in which the strata composing the Coal Measures are usually laid out, are facts of the *highest importance* as connected with the *accessibility* of their mineral contents. From their *inclined position*, the thin strata of Coal are worked with greater facility than if they had been horizontal; but as this inclination has a tendency to plunge their lower extremities to a depth that would be inaccessible, a series of faults or traps is interposed, by which the component portions of the same formation are arranged in a series of successive tables, or stages, rising one behind the other, and *elevated continually upwards towards the surface* from their lowest points of depression. A similar effect is often produced by undulations of the strata, which give the united advantage of inclined position and of keeping them near the surface. The basin-shaped structure, which so frequently occurs in Coal-

fields, has a similar tendency to produce the same beneficial effect." *

Thus, we perceive there is truly an order and adaptation to the place in all things, so as to evince power of intention in such a way as to lead up to God, the creator and governor of all things.

The disturbances, above adverted to, are mostly of a local and circumscribed character, affording very striking facilities for reaching and working the Coal seams of extensive areas ; but in comprehensively viewing the large tract of country comprised within the indicated natural limits of the Anglo-Belgic basin, it may be well also to glance at the class of upheavals, of an immensely more extended scale, and which, also, may have very effectively operated in bringing up, *en masse*, extensive tracts of Coal Measures within the large area in question, where they are concealed by the newer deposits. In the present instance it would be foreign to our purpose to attempt an inquiry into the elemental character of the agencies which nature employs to produce such stupendous dynamic phenomena. To some of them are ascribed a sudden and violent, and to others an inappreciable, gradual, motion.

Mr. Evan Hopkins has ably and ingeniously applied the doctrine of magnetic currents to the oscillations

* Dr. Buckland—"Introduction to Geology," part i., p. 377.

of the earth's surface. Certain it does appear that a dynamic power has slowly elevated vast tracts of country, as exemplified in the gradual rising of the shores of the Gulf of Bothnia and the northern coast of Sweden and Denmark. Very remarkable changes of this kind are constantly going on in South America. In the Straits of Magellan the earth has been raised more than sixteen feet, Talcahuano seventeen feet, Vina twelve feet, in twelve years, and Cohya five feet in two years! The earth's surface has also been perceptibly raised within a few years at Panama and San Blas.

Disturbing causes, apparently of a more violent character, have upheaved the mighty Hymmalaya ranges, and which have borne up with them vast beds of the *Oolitic* system. Ammonites and Belemnites have been dug out of their sides, along the line of perpetual snow, 17,000 feet over the level of the sea! We have witnessed very similar examples of upheaval in the Alps and Pyrenees. Some of the loftiest crests, and ponderous basset edges, of nearly vertical strata of the older rocks of the latter, are occasionally covered by groups of strata belonging to the Secondary and still newer deposits. These few examples may serve to show the power and general distribution of such stupendous phenomena. And, within the confines of our own island we are not without abundant evidences of their startling operation. In the peninsula of Morven, Argyleshire, consisting principally of gneiss, an instance

in point occurs too remarkable to be passed over in silence : the Coal and its concomitants here, in some places, occupy the summits of primary mountains exceeding 2,000 feet in elevation.

It has not unfrequently been very absurdly argued that Coal, if found, could not be worked from certain of the midland and south-eastern districts of the country, on account of the general height of the tableland composing its surface, as indicated by the tributary streams and rivers which take their rise therein, and flow to the sea in almost every direction, the argument being mainly based on the fallacious idea that Coal always occupies very low relative situations—*i. e.*, with regard to the level of the sea. Two or three familiar instances will suffice to dispel this illusion. The Coal Measures of Ashby Wolds are about 215 feet above the level of the sea ; at Simonside Hill, in Northumberland, they attain the height of 1,407 feet ; and at Holme Moss, Derbyshire, they reach the height of 1,859 feet above sea level.

Somewhat elaborately and, it is trusted, impartially, have we endeavoured to avail ourselves of “observed facts,” in order to elucidate the position mainly sought to be maintained—the existence of ample fields of Coal at attainable depths beneath the secondary formations of England, and it is believed, the *case* is not only a *strong one* in its geological bearings, but very encouraging to the enterprising explorer, and who, in fact, alone can

solve indubitably this great question, of daily increasing national importance.

In the great majority of these pioneering experiments, the engineering skill and improved mechanical appliances of the day will be found quite adequate to more than the ordinary difficulties inseparable from such undertakings; but these, with ample means and perseverance, will be indispensable in the exploration of the ground as yet so unbroken by the miner, and into the dark recesses of which, the lamp of science casts but a dim and uncertain light.

The evidence already adduced affecting the actual character of the obstacle regarded as the most formidable—that of depth,—demonstrably, exhibits the fallacy of exaggerated notions too commonly entertained thereon. On this point we have directed especial attention to the remotely ever-recurring *havoc*, occasioned by denudating agency, locally, and often most extensively, committed on the great sedimentary formations more immediately superimposed on the Coal Measures; leaving here and there valleys and breaches wide and deep, or sweeping away whole series of stratifications from the parent deposition. And as we everywhere see the superficial beds thus scalped and scared, it may safely be inferred that like effects pervade the subjacent classes of strata. Moreover, in these regions of inscrutable concealment, it is physically impossible to determine whether any portion of a series, or perchance an entire system of rocks, have ever

been deposited there at all. The solution of such facts obviously, must solely depend on the operations of the sinker or the borer.

We have only to go to a spot already indicated on the southern side of the Chalk ranges to discover that the New Red Sandstone, Liassic, and Oolitic systems, at least, have altogether vanished from their assigned geological position, possibly thinned out long before reaching the Greensand and Cretaceous deposits of Dunstable. Ascertained conditions like these, indubitably attest that the received geological estimates of the thickness of these and other sedimentary depositions, have, very commonly, to be subjected to *reductions vast and various*.

Two or three interesting trials singularly corroborative of these views occur to us at the present moment. At Southam, Warwickshire, by boring for Coal from the surface of the Lias, the New Red Sandstone was reached at a depth of only 116 yards, being about 200 less than the geological estimate. At Kingsthorpe, near Northampton, as above intimated, the New Red Beds were proved by the same process to exist there at a depth of less than 300 yards from the surface of the Great Oolite. Whereas, an authoritative public statement had averred that the Oolitic and Liassic beds alone would be found to be 600 or 700 yards thick at that spot. And, lastly, at Woodhall—near Horncastle, in the heart of Lincolnshire—situated on the Kimmeridge

Clay, near its junction with the Greensand, a bore-hole was put down for Coal upwards of twenty years ago, which (*geologically*) descended through the former deposit, the Oolitic system, and Lias beds, and some distance into the New Red Sandstone, where, at a depth of about 380 yards, a valuable *saline* spring was discovered, and which has ever since been greatly resorted to by invalids. These medicinal waters are found to be peculiarly beneficial in rheumatic complaints, scrofula, and chronic affections of the liver. They contain about one-eighth of a grain of *iodine* to the pint.

In travelling in a direct line westward, from Horncastle to the neighbourhood of Kettlethorpe (where the Upper New Red—Kuper, disappears beneath the Lias formation), the Kimmeridge Clay, Upper, Middle, and Lower Oolites, and Lias, ranging north and south, *are all intersected*, and found, for the most part, to be extensively developed on the surface, the distance between the two extremities intimated being little less than thirty miles; altogether strikingly manifesting that the entire series in question here, as elsewhere, *proved* in depth, fall very short in vertical dimensions of the ordinary published estimates.

In discussing the more prominent features which have an especial tendency to afford a favourable solution of the so extensively unresolved problem under inquiry, it has been requisite to dilate somewhat considerably on “disturbing forces,” but in so

doing it was by no means intended to inculcate ideas of misrule and disorder, as principles, pervading any department of the subterrene regions. On the contrary, we are persuaded that *chance* has no part whatever in the arrangements, or disarrangements, observable throughout the vast and varied field which the geologist claims as his own, and in the investigation and study of which, in every phase of its abounding and instructive phenomena, he would do well to make it his guiding principle that God hath made all things, and impressed upon them those laws which we behold now in actual operation; and if any of the facts of geology seem to contradict this principle, those facts must be misinterpreted or misunderstood.

In no division of the great geological tableau, representing the crystalline "pillars," and superincumbent stratical structure of the crust of the earth, are the laws of order and the purposes of design more strikingly and beautifully displayed, than in the series comprised in that part of the "Medial" system constituted of Coal and its concomitants; and perhaps in no other series are the varied effects of disturbances so palpably manifested; yet these harmonise with, and are but a necessary part of, the perfect whole. It is impossible thoughtfully, to contemplate this magnificent treasury of nature, without being constrained to acknowledge that in the conservation and constitution of these striking terrestrial adaptations, there is every-

where displayed a wise provision, a painstaking, prospective regard for the welfare and happiness of the human race. Nor can we thus mark these beneficent creations, without feeling the conviction strong within us that, "He that sendeth the rain hath the winds for His messengers, and that they may do His bidding, the *land* and the *sea* were arranged, both as to position and relative proportions, *where they are, and as they are.*"

The student of Nature, should ever be mindful, that to *observe correctly* and to *judge rightly*, are amongst the highest attainments of man ; with this principle ever before him as a guiding star, he will find himself insensibly led into paths of increasing radiance, and her ever varying and wondrous arcana, gradually unfolded before him, clarifying his intellect and cultivating his soul ; and as new truths continue to reward his diligent investigations, he will, irresistibly, be led to exclaim with the Poet—

"These are thy glorious works, Parent of good—
Almighty ! thine this universal frame,
Thus wondrous fair ! thyself how wondrous then !
Unspeakable ! who sits above these heavens,
To us invisible or dimly seen
In these thy lowest works ; yet these declare
Thy goodness beyond thought, and power Divine."

CHAPTER V.

DOES COAL EXIST NEAR LONDON? GEOLOGICALLY
CONSIDERED.

THE reiteration of this often-mooted question will, in all probability, cause the smile derisive to mantle on the face of the man of geological tomes and inviting published sections. Be this as it may, we trust, by an impartial and attentive investigation of the problem, to induce even such an one, eventually, to lay aside his preconceived notions, and to acknowledge it to be worthy of serious consideration.

As there is, necessarily, a great similarity in the leading facts and circumstances which have formed the subject of the foregoing disquisitions, and those we have now to examine, this apparently more formidable investigation may be approached with increased confidence and consistency.

It being most desirable, in a question of this character, steadily to entertain just and comprehensive conceptions of the magnificent scale on which Nature, commonly performs these her mundane operations, even though such views be merely confined to the known Carbonaceous stores of our own Isle,—and they embrace an extent of 11,859 square miles—we, perhaps, cannot do better than by recurring, in the first instance, to the expansive Anglo-Belgic

and French basin, which we have attempted to delineate in reference both to its general outline, and probable Coal deposits before they were, for the most part, concealed by newer formations.

Special attention has been called to the fact that, extending north and south, through the inland districts of England, we have a concatenation of the superficial Coal Measures of nearly 200 miles in length, and as having, in various localities, been proved to dip beneath the secondary depositions to the east and south-east, we know not whither ; now, from the most southern point of the Warwickshire Coalfield, the distance to London is barely 100 miles ; and reasoning from analogy, it will surely not be wandering into the region of vain hypothesis to suppose the actual continuation, in the same direction, of the great Coal formation, even far to the southward of that city.

If, then, we proceed onwards, from thence, and cross the Straits of Dover to Calais, an additional distance of but about eighty miles, we again find ourselves in the vicinage of the Carboniferous strata, the Belgian Coalfield having now been traced, and the Coal profitably worked, as far as the *Pas-de-Calais* ; and is said to have been proved, by boring, to exist immediately under the Chalk beds at Calais. Continuing to journey eastward from the latter place, over Chalk and Tertiary deposits, reposing on Coal Measures, for an extent of about sixty or seventy miles, we arrive in the neighbourhoods of

Lisle and Valenciennes, where the superficial Coal formations of French Flanders and Belgium abound, and constitute, thenceforward, broad denudated tracts of country, stretching far away to the eastward, in Belgium, partially bordered to the south by an extensive range of Mountain Limestone.

This great *northern group* of Coalfields—including those of the departments of the Nord and Pas-de-Calais—stands almost unrivalled in the richness of its Carbonaceous deposits, and perhaps the same may be said, as to the full and extraordinary development, of their accompanying measures. These, contain between seventy and eighty seams of Coal.

The belt, containing this series of rich Coal-basins, of which the above forms a part, extends about 150 miles long, and six miles broad; it contains the Coal mines of Valenciennes, Conde, Douay, Mons, Namur, and Liège; at the last-named place the measures are said to comprise eighty-three beds of Coal. The eastern division of the Belgium Coalfield contains nearly 100 Coal seams, varying in thickness from a few inches to six or seven feet.

This great Continental zone, or rather chain, of Coal formations, all trending in an east and west direction, may be seen in large denudated areas, stretching through Germany, Prussia, and Poland, into Southern Russia, where, between the Dneiper and Don, the Coal Measures occupy an area of not less than 11,000 square miles.

The geographical *extent* of this vast run of Carboniferous strata, having an *important bearing* on the question at issue, and the geological conditions being of a very similar character to those which will presently come under consideration in treating of the sedimentary deposits of the South of England, we may here notice that a German authority,* in remarking on the rich Coalfields of Upper Silesia, says, that "the most extended Coal Measures of the whole district occur in the south-eastern Silesian civil districts of Ratibor, Rybnick, Pless, Beuthen, and Tost, in the department of Oppeln. They cross over the limits of the Zollverein into Moravia, Austrian Silesia, Cracau, and Poland. Only a restricted number of them *appear on the surface*, whilst *large portions* remain covered by *Diluvial*, *Miocene* (Middle Tertiary), and *Muschelkalk* beds (Shaly Limestone—Triassic). It may, however, be assumed with some degree of certainty, that the measures are *continuous throughout the entire space* in which small (denudated) portions have become known. This immense subterraneous treasure not having been used before the year 1784, it is not to be wondered at, that even now its easily attainable parts open a wide field to the industrial energy of our days. As for those portions which have as yet remained entirely unknown (immediately beneath the younger formations referred to), it is believed,

* M. Von Dechen.

that *they will acquire a greater importance than those now under operation have attained to.*"

Reverting from the cursory view now taken, of the more eastern portions of the great Coal repositories under notice, and returning to their denudated western extremity, in the Pas-de-Calais, we find the Coal and its concomitants dipping west, in very general conformity with the Chalk beds, towards the white cliffs of Albion. These Cretaceous deposits, with Tertiary beds and Diluvium, more or less conceal—as already intimated—the Coal Measures as they approach the French shores of the Straits of Dover ; repassing which, and continuing westward over narrow zones of Chalk, Tertiary, Greensand, and some attenuated beds of the Oolitic system, we arrive at the Somersetshire Coalfield, the nearest to London. This curved Coal tract—of about 150 square miles—presents several denudated areas, and ranges over a considerable extent of country, from Frome, near the Chalk hills, northward, into Gloucestershire, extending some twelve miles north of Bristol. Many important tracts of these Coal Measures, are overlaid by thin depositions of Lias, Oolites, and New Red Sandstone, and from the surface of which, the Coal is occasionally extensively wrought. The respective formations are for the most part conformable, and dip to the eastward. And the inference is a fair one, that the Chalk ranges and Coal Measures of France and England, adverted to, are *co-extensive*.

Now, before entering into further investigations of a local character, it is desirable, at this point, to glance at the general geographical disposition of the great Coal tracts which come within the range of our present inquiries. The Coalfields of the Northern Hemisphere are said partially to encircle the globe in the character of a vast zone, extending from about 42° to 62° , or perhaps, if Melville Island is included, to 75° of north latitude. But those worthy of especial notice, in the present instance, all lie within the parallels of from 50° to 55° of north latitude. They include all the Carboniferous deposits we have enumerated, as comprising the immense belt of Continental Coal basins, as also those of England, Wales, and Ireland. If a line were drawn, say from the Coalfields of Southern Russia to those of Munster, in the south-west of Ireland, it would intersect nearly all the intermediate ones particularised—viz., those of Poland, Germany, Belgium, Northern France, and Somersetshire. Thence, proceeding to the Coal tracts on the estuary of the Shannon, and crossing the Atlantic between the same parallels of latitude just adverted to, we first meet (inclining southward) with the extensive Coalfields of Newfoundland, Nova Scotia, and Cape Breton, and, on verging inland, to the S.S.W., towards the Alleghany Mountains, encounter the great Carboniferous formation of the United States, occupying altogether about 200,000 square miles, *a Coalfield which would cover half Europe.*

We may seem to be far outstepping the bounds of the present examination in passing over to America for an illustration in point, but our object is a *suggestive* one. In contemplating the mineral resources of the vast plains alluded to, we cannot but be struck with the very ample provision Providence has thus made, for the exigencies and ordinary requirements of the inhabitants of this Great Northern division of the New World, where the climate most demands it, and in a proportion commensurate with its abounding territorial extent. And are we not, therefore, in this benevolent aspect of the inquiry, justified in believing that a like provision, has been made for the human necessities of this identical quarter of the Old World, in the magnificent subterranean storehouses of Coal we have indicated, as actually existing, nearly in lineal conterminous position, within compass of the above-mentioned five degrees of latitude? in short, mainly constituting, in denudated, or concealed areas, with their neighbouring outlying Coal tracts, the *Great Coal repository of Europe*.

The more important Coalfields of England, and those we have alluded to in the Continental border countries of the German Ocean and Straits of Dover, are too commonly viewed as distinctive, and inevitably unconnected, as though the intervening oceanic waters formed a positive barrier between these home and foreign Coal deposits; whereas, in a geological sense, certain of them may deducibly

well be supposed to constitute, one vast subterraneous and subaqueous deposition of the Coal Measure series,—a conception quite within the limits of the grand scale on which nature has very commonly elaborated these invaluable treasures. A striking example in point, is adduced by Professor Morris ; he states that *one seam*, the Pittsburg seam (American), extends over an *area of 14,000 square miles*.

It is trusted that the several general facts and illustrations just referred to can hardly fail, in the mind of any one who has duly considered them, to warrant the conclusion that extensive deposits of the old Coal formation do exist beneath the younger sedimentary strata of the southern counties of England ; indeed, it would almost seem a geological anomaly to suppose this particular link, in the great Carboniferous concatenation we have described, in its lineal east and west direction, would here be found altogether absent ; on the contrary, geological induction points very encouragingly to its large development in this unexplored division of the kingdom.

Moreover, we have certain local evidences, presenting marked and peculiar features, strongly corroborative of these views. The Somersetshire Coalfield, in its singularly contorted Coal seams, and the fact of their often deviating from the parallelism so characteristic of nearly all the other Coalfields of England, impart to the former a very

cognizable and distinctive character; and these peculiarities of structural development are identical with the saddle-shaped contortions, and other marked features, known to distinguish some of the Continental Coal series above referred to, and especially those of Mons and Liège.

Mr. Greenwell, a gentleman very well acquainted with the peculiarities of the Mons and Somersetshire Coalfields, in an interesting paper communicated to the Manchester Geological Society, "On the South-eastern Portion of the Somersetshire Coalfield," draws the conclusion that these Coalfields belong to the same period of the formation of Coal, and that the contortions of the respective fields, from their similarity, are attributable to the same cause. In both fields it is shown by diagrams illustrative of these peculiarities, that a shaft might pass through the same seam of Coal thrice. And it is observed, that when near the Carboniferous Limestone, on the northern skirts of which the measures of both the Belgian and Somersetshire fields repose, their lowest seams rise to the day from the bottom of the basins, exhibiting the contortions adverted to. Furthermore, "in both localities the seams of Coal are of a similar character, being soft, pure, and bituminous, and infested with fire-damp. And in the respective localities northward from the steep and contorted measures, are seams of Coal comparatively flat and free from fire-damp, which, although lying at a considerable depth, are yet

some thousands of feet above the seams first named, which, when necessity demands, will, no doubt, be sunk to, and in all probability found in the greatest perfection."

It has been shown that the rich Coalfields of Herault, &c., in their approach to the coast in the neighbourhood of Calais, incline westward, beneath the Cretaceous and Tertiary beds, here resting immediately upon them; the Mesozoic group—intermediate formations of Red Sandstone, Lias, and Oolites—being altogether absent, with the exception of some patches of the latter considerably to the southward, in the departments of Ardennes and Meuse, where the Cretaceous system, still predominates. The Belgian Coal Measures are occasionally to be seen in immediate sub-contact with the *Maestricht* beds—Belgium Upper Chalk, with Flints.

We may here take a brief discursive survey of the geological formations, extending from this point westward, through Northern France; they, for the most part, having a significant relation to the cognate ones on the opposite shores of England. The Cretaceous, Pleocene, Miocene, and Diluvial deposits occupy, more or less, nearly the whole of the North of France, as far west as the neighbourhoods of Moulins, Alencon, and Beaumont, where the Superior, Middle, and Lower Oolites are seen, presenting (in a contrary direction to those of this country) their escarpments to the *east*. These Oolitic ranges, hence, extend southward into Cen-

tral France, and northward into the department of Calvados, by way of Caen, to the embouchure of the Seine, there in bold ridges constituting the west bank of the river. On the opposite shore of the English Channel this Oolitic system again appears, forming St. Alban's Head and the Bill of Portland, and shortly disappearing beneath the Chalk hills, and emerging from them again to the north of Dorchester, trends away in bold undulating ridges to the north-east coast of England. The three well-defined divisions of the series appear to be, throughout the course here intimated, for the most part, *co-extensive*, and remotely have thus, doubtless, *continuously*, through both countries, constituted a magnificent segmentary range of the whole system.

The Oolitic beds of Caen, in Normandy, are shortly succeeded to the westward by the Transition, and Primary Rocks of Brittany, running northward to Cherbourg, Granville, Jersey, Guernsey, and *Alderney*; the latter Isle containing strata which have been considered by the initiated to belong to the *Millstone Grit*. If so, this may be considered an important feature in support of our position. In recrossing the Channel, to the opposite coast of Devonshire, the above Transition and Primary masses again present themselves. The *Millstone Grit*, on which the Coal Measures of England and Wales so frequently lie immediately superimposed, is to be seen cropping out from beneath the Bristol Coalfield, and is very extensively developed in

Devonshire, north of the lofty granitic ranges of Dartmoor, and entering the Bristol Channel, is again seen emerging from beneath, and nearly encircling in a narrow belt, the great Coalfield of South Wales.

Once again, in reference to the formations on the Northern Coast of France, we find the Cretaceous system and Tertiary beds forming the undulatory border lands, all the way from the estuary of the Seine to the vicinity of Calais, with the exception of an outlying patch of Oolite, forming the country about Boulogne. Approaching Calais, the Greensand crops out from beneath the southern escarpments of the Chalk beds, and on the opposite shores of Kent their equivalents appear precisely under the same geologic conditions.

The evidences, direct and inferential, now adduced in reference to the *existence* of the old Coal formation series, beneath the newer depositions of the south of England, are, we imagine, of a character not to be disregarded even by the most sceptical; and in the minds of those who are duly prepared to appreciate geological phenomena, they must, altogether, be considered to present testimony of much weight and importance.

The bare fact alone, of so rich and fully-developed a volume, of Coal Measures being partially traced, trending in nearly a direct line from east to west, for hundreds of miles together, up to, as it were, the very portals of south-eastern England, is, in itself,

strikingly suggestive of the existence of Coal, *in situ*, near London. In short, it is hardly possible to conceive of such a vast massive pile of these Carboniferous stratifications being *THERE abruptly terminated*; and at a spot, too, where there are no apparent geological impediments to give countenance to such a supposition. On the contrary, the existing circumstances strongly warrant a belief that, the great Belgian and Northern France group of Coal-fields are really co-extensive with the associated Chalk beds, say from the point where the measures last disappear beneath them (near Douay) to the west, until they are seen again a few miles westward of the Chalk escarpments of Wiltshire.

We may here remark that the growth of the Coal production of the Pas-de-Calais has been remarkable during the last fourteen or fifteen years. The Coal-workers have now, it is estimated, expended £2,000,000 in order to render available the subterranean riches which have so bountifully been conceded to them; and so great has been the demand for Coal of late, that the production for 1865 is estimated at 16,000,000 hectolitres, or not far short of ten times the total attained in 1855. A hectolitre, it may be added, is 198lbs. English.

THE ACCESSIBLENESS, of these highly probable stores of valuable Coal, from the surface of any of the southern districts of this country, is the next important matter for investigation. We may, therefore, properly commence the inquiry by referring, briefly,

to the principal sedimentary deposits by which it is here mainly occupied.

In traversing the country in a direct line from Dover to the Coal tract of Frome, Somersetshire, the more notable formations passed over in succession are the North Chalk Downs, which attain the height of nearly 1,000 feet; then the Upper and Lower Greensands, Chalk, Marls, and Greensand, then the elevated Chalk ranges of Salisbury Plain, to the borders of Wiltshire, where the Upper Greensand crops out from beneath them, succeeded by narrow, imbricated, strips of Middle and Lower Oolite, near to *Frome*, where a belt of Mountain Limestone commences, forming the southern border of its valuable little Coalfield. Beds of inferior Oolite lie immediately superposed on the northern skirts of its measures, and proceeding nearly in the same direction into the Bristol Coalfield, it also will be found, as already stated, very commonly overlaid by thin depositions of Oolites, Lias, and New Red Sandstone. The several formations above enumerated have a general dip to the south-east.

Very considerable areas of the Chalk beds are covered and concealed by the Tertiary deposits of the London and Hampshire basins, and which are remarkably separated by a broad and elevated ridge of Chalk, that extends from Salisbury Plain to the north-east of Winchester, "where it divides into two ridges, one the North Downs, running through Surrey and Kent to Dover, the other, the South

Downs, through Sussex to Beachy Head. The beds of these North and South Downs dip north and south respectively, the former presenting a steep escarpment towards the south, and the latter a corresponding escarpment towards the north, in the valley between which the inferior rocks are exposed. In the centre of this valley rises a ridge composed of the Hastings Sand, which forms an anticlinal axis, running nearly east and west from about Winchelsea to near Salisbury Plain. The beds, which have been bent into an arch over this line, have been *largely removed by denudation*, of the effects of which this Valley of the Weald is a beautiful example."

The Wealden group, which may be described as a series of clays and sands, with subordinate beds of Limestone, Grit, and Shale, is largely developed in the south of Kent, Sussex, and Surrey. It *underlies the Cretaceous system*, and is bordered on almost all sides by narrow, overlapping deposits of Upper and Lower Greensand, with occasional beds of the intervening Galt Clays. The whole series of Wealden beds is stated by Sir Charles Lyell to be from 700 to 800 feet thick. Dr. Mantell considers the entire group to be of fluviatile, or fresh-water, origin. It dips to the east below the Greensand, near Hythe and Folkstone, but does not appear to extend in that direction as far as the Pas-de-Calais, where the Coal Measures and Chalk beds are in immediate contact. Viewed as a *fresh-water* deposit

underlying some 1,000 feet in thickness of *Marine* beds, and, in a local sense, apparently geologically placed between the latter and the French Coal Measures, from which its eastern extremity, in Kent, is, comparatively, at no great distance, it assumes a very interesting and suggestive character.

The Wealden beds, like the great majority of the deposits above adverted to, have suffered greatly from the joint influences of elevatory and denuding operations. There is every reason to believe that the Chalk was once continuous from Shakespeare Cliff to Beachy Head, and that the North Downs of Surrey, and the South Downs of Sussex, were once united, until those denudating forces which formed the Wealds swept away all the Chalk which lay above the Hastings Sand.

There are, in various localities, evidences of great disturbances having occurred under the Chalk and above the Hastings Sand; they are for the most part apparent in extensive denudations, and the destruction of previously-existing formations. Mechanical movements are exhibited by the anticlinal axis of the Wealden group, the axis of subsidence in the Cretaceous beds, the vertical Arenaceous and Chalk strata of Alum Bay, the junction of vertical and contorted Chalk beds at Ballard Head, Dorsetshire, and in the apparently sudden changes in their area,—as inferred by the alternations of marine and fresh-water deposits of the Isle of Wight, and which of itself, is considered as a disrupted mass of the

formations of the adjacent south-east coast of England.

A palpable upheaving of the lower strata occurs between Reigate and Godalming; for Leith Hill, near Dorking, consists of Hastings Sand, which, geologically, has its proper place full 500 feet below the level of the North and South Downs; yet Leith Hill rises full 200 feet above the North and South Downs. The neighbouring valley of the Weald was scooped out after the upbursting of the sand; and as a similar denudation reappears on the French coast near Calais, it is considered this convulsion preceded, or accompanied the separation of our Island from the Continent, and before that time the Straits of Dover did not exist.

The few examples above cited, sufficiently testify to the nature of the mechanical forces which, in these southern counties, as elsewhere, have so largely operated, not only on such systems of rock strata as are exposed to view, but on those of the sub-formations, where, also, it frequently happens that only a few solitary members of a group are developed, and those very scantily. Occasionally whole formations are observed to be absent from their assigned position. For instance, at Lyme Regis, the Lower Greensand reposes on the Lias, and at Axminster on the Red Sandstone respectively, exhibiting an immense hiatus in the regular sequence of formations. At Broadway, in the neighbourhood of Weymouth, the Chalk beds rest.

on the Upper Oolite, the intermediate groups of Lower Greensand, Hastings Sand, and Purbeck beds being wanting. These effects may have resulted, from the absent beds never having been deposited in those situations, or from their having been denuded by the erosive power of fluvial action, or oceanic currents. Moreover, these great sedimentary deposits are found to be of very variable thicknesses in different localities. To adduce examples would be an endless task; one, however, we may mention: at Hythe, in Kent, the Lower Greensand is 400 feet thick, at the back of the Isle of Wight it is upwards of 800 feet.

As compared with the computed geological thicknesses of the sedimentary deposits, singly or in the aggregate, the deviations and modifications we have exemplified, as so constantly occurring in nature, are very encouraging circumstances to the mineral explorer, contemplating trials for the discovery of Coal in these untried districts, where the Newer Formations effectually conceal it, as with a mantle, where-soever, therein, it may exist.

But, independently of these obvious phenomena, there are the disturbing and elevating forces, the vast inequalities of the great crystalline masses, on which the Coal Measures repose, which occasionally might, also, serve to place them within easy reach of the miner, in some of the unexplored tracts under consideration. The great faults which so numerously occur in the Coal formation, are well known com-

monly to elevate the strata on their dip, over and over again, throughout vast extents of country. These stupendous dislocations of the Carboniferous series frequently, enter the overlying Secondary Formations, as at Paulton Hill, in Gloucestershire, &c. Similar faults, and slips, are also very frequently met with in still younger groups and strata, all, more or less, affording singular facilities to the operations of the quarryman and the miner. But these dislocations are commonly, very effectually concealed from human ken by vast beds of adventitious clays, and other diluvial detritus, often so extensively concealing the regular formations.

From the partial survey now taken of the general character, and disposition, of the regular sedimentary deposits interspersed throughout the greater part of the southern area under discussion, we may next glance at the important consideration which, a skilful and judicious selection of sites for Coal trials involves. For any first attempts of this kind, localities situated clear of the Cretaceous and Tertiary beds, are obviously the most eligible; though there are, for reasons already intimated, numbers of localities where even as to aggregate thickness these younger, and for the most part thinner, groups of strata would offer no very formidable obstruction; but in contemplating such experiments, the most serious query for solution would be that of the presence, or absence, of the Secondary Formations. The latter view, from what has been stated re-

specting them, would appear the more probable one.

Let us, for a moment, pass to the northern skirts of the Chalk ranges for the selection of a *central* position-site—for some, well-directed, *experimentum crucis*. Aylesbury, in Buckinghamshire, is on the outcrop of the Upper Oolite, on the verge of the Lower Greensand, and but a little more than thirty miles, in a direct line, from the southern extremity of the Warwickshire Coalfield. Woburn, in Bedfordshire, is situated on the Lower Greensand. The neighbourhoods of either of these towns are suggestive of geological, and geographical, advantages for such a trial. The Liassic, and Oolitic systems, though of very considerable development in the central portions, of their north-eastern and south-western range are, in England, comparatively, but local deposits, and as they trend thence, to the northward and southward, gradually become very sensibly attenuated, and of diminished surface range, and probably would be found of inconsiderable thickness at the above places, as was the case at the Kingsthorpe Coal trial, near Northampton, and where, as heretofore remarked, the New Red Sandstone was penetrated.* Considering the immense

* The proportionate distribution of the principal English rocks is computed as follows: Granite occupies an area of 1,000 square miles; Trap, 1,000; Silurian, 1,000; Devonian, 6,000; Mountain Limestone, 1,000; Coal, 10,000; New Red Sandstone, 10,000; Lias, 2,000; Oolites, 7,000; Greensand, 2,000; Chalk, 6,000;

area occupied by the latter in the Midland and Northern Counties, it would very probably be found as far south as Aylesbury, perhaps further, though we must not be unmindful that even that formation, with its Secondary congeners, is entirely wanting beneath the Chalk immediately on the other side of the Straits of Dover.

As any good practical geologist, or mineral surveyor, could by careful actual investigations, doubtless point out numberless spots, clear of the Chalk and Tertiaries, most suitable for trials of this character, we shall here only advert to one more locality, or rather district, which in our own estimation appears to be, in a geological point of view, the very best in the South of England, and that is, the *Valley of the Weald*. As already explained, the position of the Wealden beds immediately below the Cretaceous system, and their comparative nearness to the Pas-de-Calais, where the Chalk is superincumbent on the Coal Measures, invests any well-chosen locality of the Wealden tract, for a Coal trial, with a pre-eminence which admits of no dispute.

Should the Wealden group be found to repose immediately on the Coal Measures—an inference, as we have seen, far from improbable—it might

London Clay, 3,000 ; Drift, 1,000. Alleged aggregate (*geological*) thickness of Lias beds, about 900 feet ; Oolites, 1,200 ; New Red Sandstone *system*, 2,200 ; Coal Measures, 10,000 (in South Wales about 15,000) ; Mountain Limestone, 1,200 ; Wealden Clay, with Hastings Sands and Purbeck beds, 600 to 700 ;—*all, ever varying.*

so happen, in the selection of a site for boring, that Coal would be found at no great depth from the surface. We make this remark in reference to the peculiarly contorted, or saddle-shaped, disposition of the Coal seams of Mons and Liège, and also those of the Somersetshire Coalfield. For should such be the character of the Coalbeds, which may extend beneath the whole or greater part of the Southern Counties of England, they would, of

CONTORTED COAL SEAMS NEAR WASMES, IN BELGIAN COALFIELD.

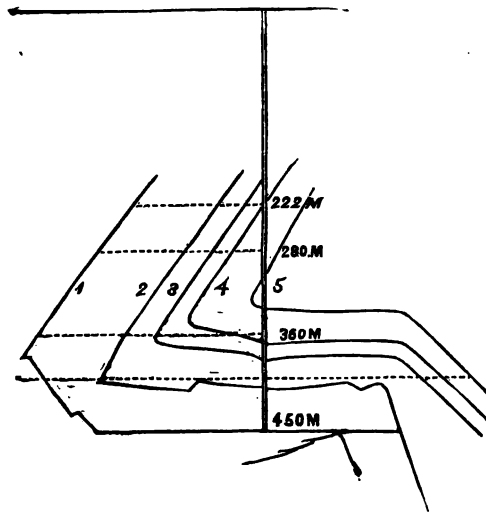


FIG. 1.

Belle Espérance Colliery, near Wasmes. Seams working : 1, Abbaye ; 2, Andrieux ; 3, Fertée ; 4, Veine à Forges ; 5, Veine au Caillon.

course, mainly be reached at alternating, or, at all events, very variable depths from the soil—deep in

one place, and shallow, at but a short distance away, in another, which might necessitate a series of explorations before the attainment of satisfactory results. Considering, however, that the distortions distinguishing the domestic, and foreign, Coal tracts referred to, occur in each case where the seams are

CONTORTIONS OF COAL SEAMS NEAR FROME, SOMERSETSHIRE, COALFIELD.

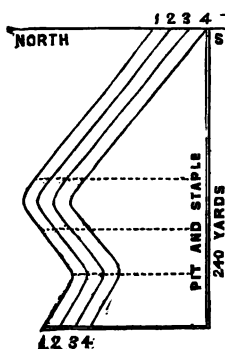


FIG. 2.

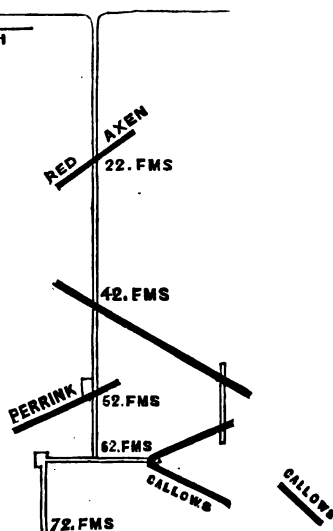


FIG. 3.

Somersetshire Coalfield.—Vobster Colliery, near Frome. Seams working: 1, Perrink, 3ft.; 2, Strap, 1ft. 4in.; 3, Shelly, 1ft. 4in.; 4, Callows, 5ft., but varying considerably. FIG. 3.—Section of Goodeaves Pit.—From Mr. Greenwell's Sections.

in pretty close proximity to the Mountain Limestone belts, it is highly probable that, as they continue to recede from those several crystalline masses,

they may assume a more horizontal and parallel position, and may thus, at least, where not disordered by disruptions and dislocations, traverse the whole of the intermediate distance above intimated. But, of course, all such peculiarities and details must remain a mystery, until these dark unsealed recesses, are duly explored by the spirit of enterprise, and the hand of labour.

The diagrams will serve to illustrate the similarity of contortions of the Coal seams, in the respective fields, and to show what is meant by the inequalities of their depth, from the surface, wherever such distortions may exist.

We have remarked that the Wealden beds, including the Hastings Sands, constitute a broad zone running east and west, through southern Kent, Sussex, and part of Surrey, lying between the North and South Downs, to the borders of Hampshire; an ample field, specially presenting itself, to the enterprising explorer.

A bed of impure Coal is reported to have been discovered in excavating for a dock at Shoreham, in Clay beds cropping out from beneath the South Downs Chalk escarpments; and on the eastern shores of Weymouth Bay, an imperfect Stone Coal of about two feet thick is found, interstratified with the bituminous Shales, and Cement beds of the Kimmeridge Clay. This two feet bed has yielded from 9,000 to 12,000 feet of gas per ton, and by slow distillation at a low temperature it produced, on a

large scale, thirty per cent. of crude oil, containing a large per-centage of parafine. The oil product, proved to be of too impure a quality for general use.*

A strip of Purbeck beds, belonging to the *Wealden* group, runs parallel to, and in contact with, these bituminous Shales. The Kimmeridge Clay is the lower member of the Upper Oolite group, and the uppermost bed is the well-known Portland Stone. The two feet Stone Coal is identical with the Brorar Coal, in Sunderlandshire, N.B., long worked, and is in the same deposit.

The Wealden formation of the Kingdom of Hanover, Westphalia, Duchy of Brunswick, and neighbouring States, contains a variety of inferior Coal seams. They are mostly very thin, but some few of anthracite and bituminous quality are extensively worked. The Wealden beds in the Osterwald contain eighteen seams, two or three of which only are workable. From the bituminous Marls of the Wealden group, near Werther, in the Teutoburger Wald, Westphalia, two pounds of tar are obtained in the first distillation from every hundredweight of Marl. Naptha springs arise from the middle beds of the Wealden series, near Edemissen and Odensee, in Hanover. Mineral oil and gas is also occasionally obtained from the Oolitic and Liassic beds of this part

* In 1858 these bituminous Shales, were vigorously developed by the enterprising firm of Messrs. Wanostrucht and Co.

of the Continent. Such products are but sparingly interspersed, as far, at least, as at present known, in the same deposits of England ; but this deficiency is abundantly compensated for by the immense magazines of Coal, belonging to the true Coal formation, treasured up beneath them, and in the denudated Coalfields. The discovery of Coal below the Wealds of Kent, Sussex, &c., would shortly turn to most profitable account the extensive beds of Ironstone, which there, by the use of *Charcoal*, formerly contributed, so importantly, to the *early* iron-smelting establishments of the kingdom.

From whatever point of view we contemplate the main subject of our present inquiries—viz., the search for the great Coal Formation beneath the newer sedimentary rocks of the Midland, and Southern Counties of England—the time would certainly appear to have arrived, for an effective prosecution of such enterprises, in the thorough solution of this great national problem.

The slow and expensive system of boring by hand-labour, is about to be entirely superseded by the patented steam-boring apparatus, which, for comparative outlay and expedition, bears no comparison with the former. In attestation of which, we need only instance the striking effectiveness of the new system, as exemplified in the recent borings at Middlesborough, near Newcastle, which resulted in the discovery of a splendid deposit of Salt Rock, eighty feet thick, above 400 yards from the surface. The

operations were carried on through the New-Red-Sandstone strata, interpolated with beds of Clay, White Sandstone, Ruddle, Gypsum, hard White Rock, Limestone, and Red Rock, down into the Salt Rock. "The total number of days occupied in boring this well to the depth of 1,312 feet was 540 ; of these, 150 were employed in pumping, to test the quantity of water, together with other stoppages, which retarded progress. The first 100 feet, when the first stoppage to test water took place, were bored in 100 days from the commencement of the work, thus showing an average of six feet per day. The average progress of the work throughout in boring days was three feet per day. The average progress for the extreme depth, including all stoppages from every cause, was two feet per day." Such machines are now being constructed * to bore a hole three feet in diameter, and probably before long will be adapted for driving levels, and sinking shafts.

Such, are precisely the kind of apparatus, highly suitable, for employment in the great work of discovery, in the unexplored divisions of the country we have descanted upon ; and unquestionably, in due time, they will make us as familiar with the treasures, and actual vertical sections of their deeply-hidden recesses, as the sounding-line has

* By Messrs. Mather and Platt, Salford Ironworks, Manchester. This boring, executed by Mr. Hommersham, Engineer, London.

already made us with, boundless regions of, *oceanic depths*. And how different will be the results, often obtained by these explorative processes, as regards the quality, position, presence, absence, thicknesses, and character of beds, or groups of strata, to our present necessarily imperfect knowledge of such subterranean facts, furnishing valuable data—new “materials for thinking,” and, above all, something tangible for daily increasing domestic requirements, and the still more rapid march of national prosperity.

Should good workable seams of Coal be discovered beneath the formations in question, even at the depth of 1,000 yards, or more, there can be little or no doubt, with our present ingenious and powerful appliances, they could be worked advantageously and profitably. It has been assumed, on the theory of progressive increase of heat downwards to the centre of the earth, that the depth of 4,000 feet is the limit at which Coal can be worked. On the supposition that the increase of heat at *greater depths* than the above continues *uniform* (at the rate of 1° Fahr. to sixty feet of depth), it is calculated that a fiery ocean exists at a depth of thirty-four miles!

But, the theory is not a legitimate inference from *observed* phenomena, and such a volume of heat, within the bowels of the earth, cannot be assumed without contradicting the received principles concerning heat. The temperature of the earth is not

uniform, as assumed in the 1° Fahr. to every fifty feet in depth-theory. Some curious facts in respect to the variable distribution of heat in the earth's crust, have been elicited by Von Dechen's thermometrical experiments; he thus ascertained, in the Prussian mines, that in general the increase of temperature is more rapid in Coal than in metalliferous deposits. At equal depths, Granite Rocks are colder than Slates. M. Becquerel has recently reported to the Academy of Sciences, at Paris, as the result of his observations, that the distribution of heat in the crust of the globe *cannot be reduced to an unvarying law*, in consequence of the *dissimilarity* of the *strata* which compose it, and which also are more or less permeable by water.

As for volcanoes, thermal springs, &c., it is beginning to be pretty generally admitted, that these have nothing to do with the question of central heat, for they are local and superficial when compared with the bulk of the earth; and all such temporary or variable eruptions are, obviously, referable to chemical decomposition and galvanic agency, and fermentation among the several oxides and alkalies, when they have accumulated in sufficient quantity. It is trusted, these brief observations will, sufficiently exhibit the hypothetical character of the assumption, that terrestrious heat is an insuperable obstacle to mining operations being conducted successfully at a depth exceeding 1,000 yards, or thereabouts. Practical men, generally,

well acquainted with deep workings, are of opinion that Coal can be profitably worked at depths of 800 yards, or more. The Monkwearmouth Coalpit is worked at a depth of 1,800 feet. At Rose Bridge, Wigan, Lancashire, a Coal shaft is sunk considerably deeper, and it is intended to extend it to a depth of 826 yards. At Duckenfield, Coal is worked at 2,504 feet below the surface; at Pendleton, at 2,135 feet; and near Wigan, at 1,773 feet; many Coal seams in Durham are worked at a great depth. One of the deepest mines in the world is at Kitzpühl, in the Tyrol; it is 921 yards below the surface. Many more instances of deep mines might be adduced, but the few cited sufficiently attest the practicability of mining operations being carried on at such depths; and it would appear, from what has been stated, that works considerably deeper might be effected, without meeting with a temperature which would be found to exceed the powers of human endurance.

As no efficient trials for Coal have, as yet, been made in any of the southern tracts of England, claiming our present attention, and from the necessary absence of all local indications of that mineral, it has been deemed expedient to take enlarged and comprehensive views of this subject, in order to adduce such inferences, and results, as seemed best calculated to its elucidation; and though we have thus, been enabled to offer much satisfactory and encouraging evidence, it would be premature to

attempt here, any calculations as to the actual locality best adapted for the discovery of the true Coal-beds, or to pretend to estimate with any precision as to what depth it might be expected to be won. But as has been explained, the extended area occupied by the Wealden group affords geologically, greater facilities to the experimenter than that of any of the neighbouring class-deposits ; and should the Secondary Formations be absent from beneath it, which from recognised facts may be fairly inferred, the depth, for the most part, may be expected to be moderate—say from 200 Fa. to 400 Fa. In short, taking the whole of the ascertainable physical facts and geological deductions we have somewhat elaborately entered upon into mature consideration, it does appear highly desirable that, in course of the first series of boring experiments, the whole of the Wealden tract, extending from Romsey Marsh, in Kent, to some dozen miles to the west of Horsham, in Sussex, should be submitted to a thorough and systematic exploration.

By the description already given of the distribution of the several sedimentary deposits, occupying Northern France and Southern England, it will be observed that their geological conditions and mineralogical character are identical ; that they were formerly *continuous* in extent, being merely *disrupted* by the waters which separate the two countries, and it becomes an almost inevitable conclusion, that the Great Coal Formation, so pro-

digiously developed in Northern France, is *also continuous*—co-extensive with the above Anglo-French Formations. It would, indeed, in a geological sense, be very extraordinary should the Coal Measure series in question (of which extent and magnitude are striking characteristics) alone be found absent on this side of the Channel.

We trust, indeed, to having rendered it abundantly apparent that, geologically speaking, in all probability, Coal does exist near London ; also, as evident, that vast stores of this invaluable mineral exist at depths accessible to man, beneath the Secondary Formations of the Midland Counties ; and though the solely experimental trials for Coal therein may naturally be expected to involve more risk, trouble, and expense than the majority of such operations in the ordinary Coalfields, we should not be unmindful that they may result in *unsealing new fountains*, rife with the elements of that wealth, which must thenceforth diffuse itself over the thirsty land in ten thousand fertilising rills, destined to impart force and volume to the ever-expanding waves of British commerce and civilisation.

It is satisfactory to reflect that, in the present day, trials for Coal in the unexplored districts are not very likely to be engaged in, in ignorance of their true geological character ; and hence, whoever chooses to co-operate in such a “dig for hidden treasure” may, to a material extent, make his own individual venture with discretion. If, in some of

the instances in question, it be found necessary to approximate to depths of 1,000 yards, or even to exceed considerably that depth, there can be no doubt that the skill and perseverance of British enterprise, with its unlimited resources and all-conquering steam at ready command, would be found quite adequate to the successful accomplishment of even such Cyclopiian undertakings ; though, we repeat, for reasons advanced, the great probabilities are, that in a large majority of the explorations, comparatively shallow depths would suffice for the accomplishment of the primary object.

Several years ago, Government instituted a series of systematic inquiries into the ascertainable productive capabilities of our several Coalfields, and estimates were made, on the data thus acquired, with a view to their probable duration ; but in these investigations the Coalbeds existing (as even then proved in some districts) beneath the New Red Sandstone of the Northern and Midland Counties were entirely omitted, and the national estimate appeared without any allusion to such concealed repositories. Since that period, however, many such additional discoveries have been heralded to the world, new lights from different and distant *secondary* tracts of country continue to flash forth similar good tidings, and are, so to speak, gradually establishing a telegraphic communication between these vast primeval treasuries of *heat*, and *light*, and *progress*, so carefully conservated in these deeper

recesses of Nature, and the busy hemispheres of Commerce, whose ever-active wheels must cease to move whenever, she may refuse to administer this primary element of motive power.

Since, the early exhaustion of our denudated Coalfields has been formally announced by such authorities as Sir R. I. Murchison and Sir W. Armstrong, the attention of the Legislature may, perhaps, be aroused to the importance of rendering some efficient facilities to the discovery trials in question, and which, at any rate, might thereby tend to give an impetus to more extended private enterprise. The day is at hand when, by every true Englishman, such discoveries will be deemed all-important. It is truly remarked by Mr. R. Hunt, that "the gems in the circlet of the British Crown are rare and costly; but it is the gems which exist beneath the British soil that give to our Queen the title of the 'Sovereign of the Seas,' and which secure to us that sovereignty. Though the diamonds of India and Brazil were to be found no more, England would remain the first amongst the nations of the earth; but were our British diamonds to be exhausted, our commerce and our manufactures would perish, and Great Britain would sink in the scale of nations."

We have remarked that the Wealden strata of Kent and Sussex contain important beds of Iron ore,—with Jet and seams of Lignite;—indeed, up to 1720, Sussex was the principal seat of the Iron

manufacture of England, but it left those counties when smelting with Coal or Coke began to supersede smelting with Charcoal; the last furnace at Ashburnham was blown out in 1827. Iron ordnance were first cast in 1543, at Buxted, in Sussex. The last great works of its furnaces were the noble balustrades and gates which surround St. Paul's Cathedral, London: they were cast at Gloucester Furnace, Lamberhurst, and cost upwards of £11,200. The late extensive and valuable discoveries of Oolitic Iron ore beds also, give additional importance to the development of the Coal series in such unexplored neighbourhoods; inasmuch as this ore, which is now being conveyed to the distant furnaces of Staffordshire by thousands of tons daily, would, of course, be far more advantageously smelted on the spot, and where, as near the Northamptonshire Iron mines, Lime, its flux, is abundant. As the Clay Iron ore of the Staffordshire field is notoriously already becoming very scarce, the wealthy ironmasters may, ere long, be induced to erect their smelting establishments on or near the new Oolitic Iron ore discoveries, as at Westbury, in Wiltshire, and very extensively on the Cleveland Oolitic ranges, Yorkshire; and in the event of which it would become highly probable, that some dashing and effective attempts might be made to reach the true Coal formation, from the surface of the younger depositions of such localities.

As being strikingly illustrative of the rapid con-

sumption, unceasingly going on in the two minerals we have been speaking of, especially as regards *Coal*, we cannot resist here giving an instance or two in point, in reference only to *iron-smelting* and the production of *steam-power*. It is calculated "the actual weight of materials necessary to produce one ton of Pig Iron is as follows: Raw Mine (Iron-stone), 3 tons 10 cwt., equal to 2 tons 4 cwt. of roasted ore; *Coal* for furnace, 3 tons, equal to 2 tons 5 cwt. of coke; *Coal* for kiln and engines, 1 ton; Lime as flux, 1 ton; total, 8 tons 10 cwt. for every ton of Pig Iron raised. And before this ton of Iron reaches the condition of manufactured, there will have been expended upon it a quantity of raw material equivalent to a weight of 14 tons 10 cwt."* What a *destruction* of *Coal*, past redemption, then, is manifested in this single manufacture alone, when it is stated that the production of the whole of the blast furnaces in Great Britain and Wales gives a total for the last year of 5,600,000 tons!

The next estimate is still more astounding, more suggestive. The aggregate *steam-power* of Great Britain is set down at 82,685,214 horse-power, or equivalent to 400,000,000 men—double the number of adult males now upon the globe. The power of steam makes England, with a population of 20,000,000, produce wealth representing the labour

* Mr. J. Robertson's "Birth and Growth of the Iron Trade." Our consumption of Coal, so late as 1780, was but five millions of tons annually.

of a population twenty times that number. And, let us not forget, this enormous additional amount of *manual labour* is the positive *creation* of our *Coal mines* !

“The strength of Great Britain,” wrote GEORGE STEPHENSON, “lies in her Iron and Coalbeds, and, above all other agencies, the Locomotive is destined to bring it forth. The Lord Chancellor now sits upon a bag of Wool, but Wool has long ceased to be emblematical of the staple commodity of England. He ought to sit upon a bag of Coals.”

The statistical facts and actual evidence adduced, in the first portions especially of this treatise, are assuredly (both as regards the enormously increasing consumption and prospective supply of Coal) most amply demonstrative, that the extension of our known Coalfields, or the discovery of new ones, has become a question of vast and vital importance to the whole community ; and we trust it has been sufficiently exemplified that, geological induction gives its abundant testimony to the probability and practicability of effecting such pregnant realisations in districts occupied by the superincumbent, Secondary, and Newer Formations ; and as the question in all its bearings becomes more generally understood and appreciated, it will undoubtedly arouse and enlist the indomitable energies of British enterprise, particularly in this age of progress, so signally productive of great and glorious results ; for true though it be that multitudes find no small difficulty in divesting

themselves of the pertinacious burrs of prejudice, and are slow in the recognition of new truths, no sooner are even *their* minds struck with the lightning of conviction, than, for the most part, they are willing to act, prompt to execute. The late gold discoveries are strikingly corroborative of this remark. And, the Bard of Avon, though less complimentary, but with equal truth, says :—

The jewel that we find we stoop and take it,
Because we see it, but what we *do not see*,
We tread upon, and never think of it.

CHAPTER VI.

PROVISION AND PURPOSES OF THE CREATOR.

THERE is one other, and that certainly not the least important aspect, in which we may satisfactorily view the great question at issue. It is impossible for any one, who thoughtfully investigates the nature and distribution of the materials constituting the crust of the terrestrious globe, not to be impressed with the most indubitable convictions that they are not only the operations of Almighty power, but of infinite wisdom and goodness. The Coal deposits, in lieu of being disseminated in mountainous regions, are almost always situated in undulating plains and valleys, which man selects for his habitation, as most genial to his nature, and conducive to the industrial occupations of civilised life. The Great Designer, Nature's God, has not scattered her works hither and thither in loose disorder and derangement, but in minutest aptitude has fitted every member of Nature's glorious commonweal, so as best to fulfil its appointed mission.

How long might twenty thousand blind men, who should be sent out from the several remote parts of England, wander up and down before they would all meet on Salisbury Plain, and fall into rank and file in the exact order of an army? And yet, this is

much more easy to be imagined than how the innumerable blind particles of matter should rendezvous themselves into a world—a world so framed and constituted, that whether we contemplate its magnificent crystalline basements, or the wonderful superstructure of mineral masses, all systematically placed, and charged with the elements and qualities of beauty, order, and utility, we are inevitably driven to discard all idea of *chance-work*, and to recognise the perfect organizations of a glorious Designer—the great First Thought.

Quite true it is that “it seems as if all that is done in nature, as well as all that is done in art, were done *by knowing how to do it*. It is curious how the language of the great seers of the Old Testament corresponds with this idea. They uniformly ascribe all the operations of nature—the greatest and the smallest—to the workings of Divine power. But they never revolt—as so many do in these weaker days—from the idea of this power working by wisdom and knowledge in the use of means; nor, in this point of view, do they ever separate between the work of first creation and the work which is going on daily in the existing world. The saying that ‘the Lord by wisdom hath founded the earth: by understanding hath he established the heavens,’ is coupled in the same breath with this other saying, ‘By his knowledge the depths are broken up, and the clouds drop down their dew.’”*

* The Duke of Argyle on “The Reign of Law.”

Nothing happens, however important or trivial, without the *purpose* of God. In the elaborated preparations for, and the building of this earthly temple, so sublimely and beautifully fitted up for our reception, we everywhere behold amazing proofs of His comprehensive purposes of benevolence. Casting a retrospective glance into the vistas of dim distance, countless ages before man was introduced upon the scene, we can truthfully picture to our minds one of the most remarkable of these epochal exemplifications. Therein, we see boundless tracts of unbroken forests of *Lepidodendra*, *Coniferæ*, *Sigillari*, and towering tree ferns, waving their graceful forms in mid-air, and densely constituting vast mystic regions of solitude and shade. The dank and steaming soil of these tropical latitudes being, indeed, everywhere prolific with a thousand beauteous forms so characteristic of the Coal-Fossil Flora. No eye of intelligence was there to gaze upon their pristine beauties ; they seem to have been flushed into life and vigour but to waste their fascinations and their "fragrance on the desert air." Yet, in verity, they were the efficient processes of glorious, though immensely distant results. In the purposes of the everlasting councils, the era arrived when, these teeming organisms, were to be laid prostrate in death, gathered into capacious repositories, there effectually sealed down, transmuted into Coal, and carefully conserved for the use and wholesome progress of the myriads of intelligent beings who, remotely, were to people the earth !

And when, with geological acumen, we come to investigate the physical peculiarities of these marvelous magazines of wealth and power, the mind becomes astounded at the direct efficiency exhibited in such an elaboration of completeness, regularity, and order. *Stratum-super-stratum* of arenaceous, argillaceous, siliceous, ferruginous, and other earthy minerals, together constituting piles of 10,000 to 15,000, or more, feet in thickness, all interpolated with rich, bituminous, or anthracitic seams of Coal, often occupying thousands of square miles, and still more wonderful, preserving a distinctiveness and uniformity, as regards both their respective qualities and thickness. The thoughtful examination of these stupendous masses, we repeat, compels the spectator to confess his utter inability to conceive of means, or to propound theories, at all adequate to account for such magnificent results. We maintain, that every such theorem as yet broached, utterly fails in the elucidation of the miraculous truths embodied in these wondrous creative displays of Divine power and goodness.

It is abundantly manifest that God, in the elaboration of His numberless creations, works by means—laws of nature; but it is no less certain that *Divine interposition* is not unfrequently rendered indispensable—is, in fact, often palpably evinced in various phenomena characterising the arena of nature. It is no less detectable in the notable peculiarities distinguishing the great Carboniferous deposits, than in the received doctrine of a succes-

sion of creations of animals and plants, unfolding itself scene after scene, up to the last and sixth geological epoch. Murchison states that, there has been an almost completely *new creation* of species in the Carboniferous epoch. And, as observes an eminent divine, if the production of organisms enough to fill a world is not a *miracle*, we may as well dismiss the term from our theology and philosophy.

Now, in regard to thickly-peopled Europe, and America's rapidly-increasing populations—not to name other inhabited portions of the globe—we thus recognise the purposes of God in the bountiful provision made for their respective progress, the contingency which occupies them, and their substantial mundane happiness.

Even these, however, are but transient and inconsequent provisions in the ultimate decrees of Providence, as compared with others likewise manifested by these great storehouses of nature. They also involve, the dissemination and the ultimate triumph of moral and religious principles. Whilst we ourselves are intently occupied in the extraction of our 100 millions tons of Coal in a year from the dark recesses of the land, we become the unconscious agents of Providential designs. England herself is evidently destined by nature long to perform a great, if not leading, part in the sublime and gracious scheme of the Divine mind—the universal spread of Christianity; when “the glory of the knowledge of the Lord shall cover the earth, as the waters cover the sea.”

Yes, both in a geological and geographical aspect of the question, the little island of Britain is obviously, physically constituted to perform a pre-eminent part in civilising and Christianising the benighted regions of the earth, even to its remotest bounds. There is something assuring and beautiful in the self-evident truth that even the "Isles of the sea" are framed, and "garnished," in accordance with the mission they are purposed to execute in the establishment of the reign of "peace on earth." The good and talented Mauray, in allusion to these physical gifts and adaptations, says, "Phlegmatic must be the mind that is not impressed with ideas of grandeur and simplicity as it contemplates that exquisite design, those benign and beautiful arrangements, by which the climate of one hemisphere is made to depend upon the *curve* of that line (the conformity of the shore line profile of equatorial America and equatorial Africa) against which the sea is made to dash its waves in the other. Impressed with the *perfection of terrestrial adaptations*, he who studies the economy of the great cosmical arrangements is reminded that not only is there *design* in giving *shore lines their profile*, the land and water their proportions, and in placing the desert and the pool where they are, but the conviction is forced upon him also, that every hill and valley, with the grass upon its sides, have each its offices to perform in the *grand design*."*

* Mauray's "Physical Geography of the Sea."

England, busy, energetic England, not only owes, under Providence, her abounding wealth and prosperity to her *black diamonds*, now realising, as valued at the Coalpit's mouth, about £20,000,000 sterling a-year, but also to her glorious constitution, founded on Christian principles. Her commercial progress and universal usefulness in the cause of liberty, civil and religious, have far outstripped all other nations, and she yet seems destined to exert an influence still greater in the coming age. Her strong arm of *steam* unceasingly carries out to heathen lands the devoted missionary, and disseminates the Bible in every clime. Her enterprising sons have planted the banner of commerce on every soil, established, in both hemispheres, numerous flourishing Saxon communities, here and there already growing into powerful kingdoms, and slowly, perhaps, but surely, bringing within the pale of civilisation the benighted aborigines, thus manifestly realising Heaven's decree for the wholesome fraternisation of all mankind.

In this cosmopolitan view of our subject, we cannot fail to mark the import of the marvellous preparation made by Divine Providence, in the physical conditions of our own land, for the unwonted progress and prosperity so remarkably characterising the present eventful times. And we have the fullest faith, that the Power which made this wonderful provision for our manifold contingencies has, so to speak, amply provisioned us for triumphantly carrying out our glorious world-wide mission of

humanising usefulness. We do not believe, for reasons advanced, that this our national career will be cut short, as predicted, in little more than two centuries, by the exhaustion of our Coalfields.

The time is at hand for our new resources to reveal themselves. In this respect we are invited to the performance of important duties, nationally, as well as individually; and what can any of us do, in anything, but our duty, leaving the rest to God? And whenever the requisite measures are adopted for the development of the mineral—more precious than Golconda's gems or El Dorado's gold,—stored up beneath most, if not all, of the vast unexplored areas specially referred to, we may rest assured that, the manifold appliances at command will, for the most part, be found fully adequate to the designed and contemplated ends. And although such undertakings will probably demand more than an ordinary amount of patient industry and mechanical skill, they would be infinitely compensated for by the consideration, that the actual disclosure of these mighty treasures would be hailed as a new and inexhaustible source of human advancement and happiness, a mighty strengthener of the right arm of British power and usefulness, and as an especial blessing to the millions of England's vast, and rapidly-increasing METROPOLIS.

Crown 8vo, One Shilling,

A BATTLE WITH THE BASALTS;

Being an Attempt to Deliver the Chief or Primary Crystalline
Masses from Plutonic Dominion.

By JOSEPH HOLDSWORTH, Esq., M.G.S.F., &c.,

Author of Papers, &c., on the "Climates of the South of Europe, and the Climate of the South-west of England, Comparatively Considered;" "Rural Scenery at Home and Abroad, in Reference to True Taste in Landscape Embellishment;" "Geology and Mineral Resources of the Principality of Wales;" "Geology and Mines of Ireland," &c., &c.

Crown 8vo, 3s. 6d., cloth,

GEOLOGY, MINERALS, MINES, AND SOILS OF IRELAND,

In Reference to the Amelioration and Industrial Prosperity
of the Country.

By JOSEPH HOLDSWORTH, Esq., M.G.S.F., &c.

"The work contains a large amount of information, which, if judiciously applied, cannot fail to prove invaluable as a means for working out the regeneration of Ireland."—*Liverpool Mail*.

"This is a highly interesting work, and will be welcomed alike by the man of science and the mere speculator, who can see in the sister country only a new and promising field for the investment of capital. Mr. Holdsworth's book is full of acceptable facts, the publication of which will, no doubt, tend greatly to the amelioration and industrial prosperity of the country."—*Cheltenham Journal*.

"The author enters fully into his subject, and points out lucidly and intelligently the character and capabilities of the soils of the 'Green Isle,' illustrates with a scientific pen the geological formations of the land, describes its mineral lodes, ores, and auriferous discoveries, its lead and copper mines, coal tracts and rocks, and speaks of matters not only of interest to the scientific inquirer, but of importance to the capitalist and mineral explorer. Rural matters are also noticed, and the beautiful rivers, romantic rocks and glens of Ireland form themes for the writer, who blends with description valuable information. In fact, he seems to have taken this opportunity for saying all sorts of interesting things about Ireland which have been neglected by other writers; and to those who feel a desire for the amelioration of the social condition, or have a desire to aid in the general prosperity of Ireland, this work will be hailed with heartfelt satisfaction."—*Bristol Mirror*.

"We cannot, of course, go minutely into all the details so succinctly and agreeably set forth in these pages; but we cannot help expressing our cor-

dial sympathy with the hopeful views as to Ireland's future which ever and anon occur. It is a favourite topic with Mr. Holdsworth, and we like him all the better on that account. With so fine a country lying almost waste at our very doors, we need not be too solicitous to cultivate the wilds of Australia or the woods of Canada. If anything will correct this passion it is such works as the present, which show how great are the undeveloped resources of the neighbouring island, and how promising a theatre for well-applied capital and labour it presents. Mr. Holdsworth's statements are sensible, full, and convincing. In this he is entitled to the thanks of every patriotic mind."—*Ayr Observer*.

"Mr. Holdsworth's work is one which invites and points out to all classes and forms of industry a rich field of undeveloped and inexhaustible enterprise. It deals with the most important considerations, which ought to decide any one, whether proprietor or farmer, in fixing his 'whereabout' on the Irish soil. We hail the prosperity of Ireland as something which will add, in a literal sense, and in the most practical and valuable form, one-third to the British dominions. While Mr. Holdsworth's work thus aims at one of the most important features of practical usefulness, and does ample justice to that aim by the minuteness and variety of its most interesting details, its author, by a happy versatility, aims also at arresting the attention of a wider class of readers, and, in so doing, successfully illustrates how much even the driest statistics may be relieved by a judicious introduction of varied matter. Thus he frequently introduces a wider scope of geological observation along with his details of local fact, and so gives an interesting breadth and analogy to his subject, which greatly enhances its readability and value. In this way Continental and other foreign geology and mineralogy are frequently grouped around his details of the Irish formations, giving a comprehensiveness to the general view, which throws much light on the entire subject. As one of the scientific thinkers of the age who take an interest in the theological part of this subject, we cordially welcome him to the thin but fearless ranks of Biblical orthodoxy; for, to us, the defence of the good old Book, to a far greater extent than has ever yet appeared, is as plain and as obvious as noonday. We conclude by heartily recommending the work to our readers."—*The Fifehire Spectator*.

"The author of this work is already favourably known for his geological research and able writings on basaltic theories in connexion with the important question of mineralogy. Did our space permit, we would give a few extracts from the chapter which refers to the commercial value of the peat, its formation, and early use. Mr. Holdsworth's volume promises to become one of the most valuable that have yet appeared on the natural resources of Ireland. Its style is very interesting, and the treatment of each subject is at once plain and philosophic."—*Banner of Ulster*.

Crown 8vo, One Shilling,

THE DEWDROP AND ITS WONDROUS MISSIONS,

Morally and Philosophically Considered.

By JOSEPH HOLDSWORTH, Esq., M.G.S.F., &c.

Second Edition, Enlarged.

"I like the elaborate and instructive notes appended to your poem exceedingly. It is a book ever calculated to be useful as it is pleasing."—*Rev. Dr. Cumming*.

HOULSTON & WRIGHT, PATERNOSTER ROW.

Original Papers, &c.,

ON

THE COAL FORMATION BENEATH THE NEWER STRATA OF THE MIDLAND AND SOUTHERN COUNTIES OF ENGLAND.

"About twelve years have elapsed since this subject was very elaborately treated by Mr. Joseph Holdsworth, in a series of papers, which appeared in our Journal about that period. In one of the more lengthened of them he—Firstly, comprehensively depicts an expansive area, as bordered occasionally by Silurian and other rocks commonly constituting the floor of the coal measures, and sometimes their barriers; secondly, particularises the distribution thereon of the carboniferous strata; thirdly, exhibits the probable sub-connexion of most of our isolated coal fields; fourthly, describes the distribution, &c., of the secondary and more recent formations overlying them; and, fifthly, appealing to observed facts, bearing on their often attenuated character, and frequent absence of groups of strata, and even of whole formations, argues against the fallacious nature of the doctrine so long pertinaciously maintained by geologists and others of the sub-insular character of our superficial coal tracts, as also that the great classes of strata almost always succeeded each other, from below upwards, in regular sequence, thus, for the most part, encircling the globe like the concentric coats of an onion. From a variety of evidence thus adduced Mr. Holdsworth drew the conclusion that the coal beds actually existed beneath vast areas of the Midland and Southern Counties of England, and not unfrequently at depths very accessible to the miner. A correspondent, a few weeks ago, called the attention of our readers interested in this subject to the above. Several years, indeed, previous to the above intimated period, Mr. Holdsworth extensively promulgated these views, on precisely the same grounds, and, in short, has not only been a strenuous advocate in this pregnant cause, but it is well known has given undeniable proofs of his sincerity therein; and it gives us much pleasure now to be able to add that he has at the present time a little work on this most important subject in the press, and which will shortly be published at our office. We are glad to perceive that at length one or two other of our notable geologists are beginning to direct their attention to the matter, and trust ere long to see it thoroughly discussed in all its essential bearings, and the public generally attracted to the practical solution of a problem of such vast consequence to the national welfare."—*Mining Journal*, Jan. 6, 1866.

